

MAG REGIONAL FREEWAY BOTTLENECK STUDY

PRELIMINARY DRAFT WORKING PAPER FOR:

TASK 6 - BOTTLENECK ANALYSIS WORKING PAPER

TASK 7 - BOTTLENECK IMPROVEMENT SOLUTIONS

TASK 8 - BOTTLENECK IMPROVEMENTS BENEFITS

Part 1

**Draft Date:
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***Submitted to:*
THE MARICOPA ASSOCIATION OF GOVERNMENTS**

Prepared by:



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Draft

BOTTLENECK ANALYSIS WORKING PAPER

Background

During the fall of 2001, Skycomp, Inc. conducted an aerial survey of the regional freeway system and identified freeways that they found congested. The sixteen congested segments identified by Skycomp are graphically depicted in Figures 1 through 3 at the end of this section. Figure 1 depicts morning peak bottleneck areas; Figure 2 depicts afternoon peak bottleneck areas, and freeway mainline crash rates for the year 2000 are shown in Figure 3.

Using the freeway operations model FREQ and traffic data collected during 2001, Catalina Engineering evaluated bottlenecks on the freeway system and identified and evaluated possible solutions to the bottleneck problems.

The purpose of this working paper is, thus, to present the following:

1. The analysis of the bottleneck areas within the 16 congested segments identified on the regional freeway system. (Task 6)
2. The identification of bottleneck improvement solutions. (Task 7)
3. The benefits to the freeway system that would result from implementing the improvements. (Task 8)

The working paper presents a summary of the bottleneck analysis results, recommended improvement projects, benefits of the improvements, and a discussion on the ranking of bottleneck projects. The appendix includes the full FREQ analysis results and additional information on each of the congested segments accumulated from the aerial observations, including Level of Service results based upon freeway densities, and crash analysis.

Analysis Methodology

The bottleneck analysis process involved inputting roadway geometrics and traffic volumes (for each 15-minute period on all ramps and the mainline for a four-hour peak period) into the FREQ model. The results were then reviewed and solutions to the bottlenecks were identified, coded into the FREQ model, and evaluated.

A listing of projects that have been identified as part of the bottleneck analysis and the benefits that would result from the improvement is provided in Table 1. During the analysis, it was found that ADOT is working on many of these projects. Therefore, a project status column is included in the table indicating which projects are already in the design/construction process. If known, the year that the project will be constructed is indicated.

The analysis also revealed that in some cases, congestion is caused by overall corridor capacity deficiencies, i.e., not enough lanes to accommodate the traffic volume, rather than bottlenecks. Thus, bottleneck projects have not been identified for each of the 16 segments evaluated.

In addition to the projects presented in Table 1, ADOT is working on two projects that address bottleneck issues:

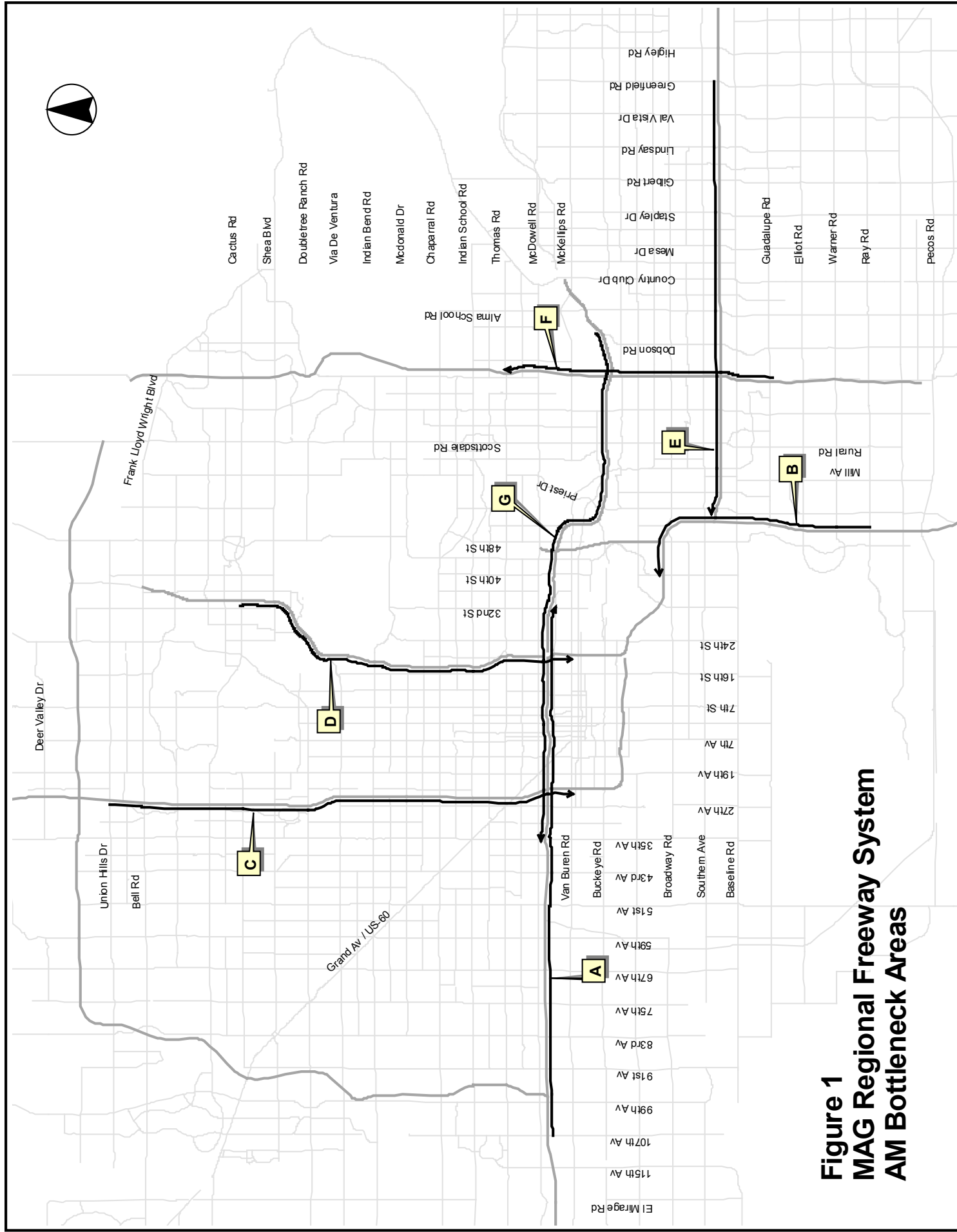
1. The HOV bypass striping that is located at 40 metered on-ramp locations is being converted to two-lane metered on-ramps.
2. I-10 through the deck-park tunnel is being re-striped to provide a 4+1+A (four general purpose lanes, one HOV lane, and an auxiliary lane) cross section.

Throughout the FREQ bottleneck analysis, it was found that system-wide ramp metering will be required to realize the full benefit of metering. While ramp metering will not eliminate major bottlenecks, it can reduce the queuing and congestion that routinely occur during peak traffic periods.

Table 1. Bottleneck Projects

Freeway Segment	Project	Benefits	ADOT Project Status (as of July 2002)	Comments
A: I-10 Eastbound: 99 th Avenue to 32 nd Street	Widen EB I-10 from Loop 101 to 83 rd Avenue to a 5+1+A section and from 83 rd Avenue to 59 th Avenue to a 4+1+A section	Decreases morning peak travel time by 2,555 passenger-hours (13%)	Under design	With these improvements, bottlenecks will still remain on I-10 at 43 rd Avenue and 19 th Avenue. However, it is recommended that, since these bottlenecks will serve to meter traffic approaching the central Phoenix area, that changes at these two locations not be made.
B: I-10 Westbound: Ray Road to 40 th Street	Construct WB collector-distributor road between Baseline Road and SR-153 (40 th Street)	Decreases morning peak hour travel time by 10,551 passenger-hours (30%)	Under study – 2008 construction	
C: I-17 Southbound: Union Hills Drive to Van Buren Street	Add auxiliary lanes between Union Hills Drive and Peoria Avenue and between McDowell Road and Thomas Road	Decreases morning peak hour travel time by 1,384 passenger-hours (6%)	Under design – 2005 construction	Additional capacity is needed in the I-17 corridor to relieve congestion.
D: SR-51 Southbound: Cactus Road to Van Buren Street	Add auxiliary lanes between Glendale Avenue and Bethany Home Road and between Indian School Road and Thomas Road	Decreases morning peak hour travel time by 2,686 passenger-hours (8%)		The planned addition of an HOV lane in the SR-51 corridor will reduce freeway travel time by 15%.
E: US-60 Westbound: Greenfield Road to I-10	None			The US-60 corridor is currently under construction. The analysis indicates that with the completed construction, congestion will still remain between Loop 101 and I-10.
F: Loop 101 Northbound: Guadalupe Road to Thomas Road	Add auxiliary lanes between McKellips Road and Thomas Road	Decreases morning peak hour travel time by 3,402 passenger-hours (10%)	Under design – 2004 construction	Congestion is created by six on-ramps within a 3.5-mile stretch.
G: Loop 202 Westbound: Dobson Road to 35 th Avenue (on I-10)	None			Improving the bottlenecks at the two system interchange on this segment would result in traffic reaching the congested central Phoenix quicker, thus exacerbating that problem. Therefore, no bottleneck improvements are recommended.
H: I-10 Eastbound: 24 th Street to Baseline Road	Construct EB collector-distributor road between SR-143 and Baseline Road	Decreases evening peak hour travel time by 4,671 passenger-hours (37%)	Under study – 2008 construction	

Freeway Segment	Project	Benefits	ADOT Project Status (as of July 2002)	Comments
I: I-10 Westbound: 40 th Street (on Loop 202) to 99 th Avenue	Construct additional general purpose lane and auxiliary lanes between 35 th Avenue and 67 th Avenue	Decreases evening peak hour travel time by 1,203 passenger-hours (4%)		
J: I-17 Northbound: Van Buren Street to Bell Road	None			
K: SR-51 Northbound: Van Buren Street (on I-10) to Northern Avenue	Construct auxiliary lane from Glendale Avenue to Northern Avenue, including a two-lane on-ramp at Glendale Avenue	Decreases evening peak hour travel time by 2,456 passenger-hours (11%)		
L: US-60 Eastbound: I-10 to Greenfield Road	None			The US-60 corridor is currently under construction. The analysis indicates that with the completed construction, congestion will still remain between I-10 and Mill Avenue.
M: SR-143 Southbound: University Drive to I-10	None			
N: Loop 101 Southbound: Via de Ventura to Guadalupe Road	Add auxiliary lanes from Thomas Road to McKellips Road and add a third lane across the US-60 interchange.	Decreases evening peak hour travel time by 1,903 passenger-hours (26%)		
O: Loop 101 Westbound: I-17 to 51 st Avenue	Add a fourth general purpose lane from 35 th Avenue to 51 st Avenue	Decreases evening peak hour travel time by 515 passenger-hours (9%)		
P: Loop 202 Eastbound: 27 th Avenue to Dobson Road	Add auxiliary lanes between Mill Avenue and McClintock Drive and make the Loop 101 off-ramp a mandatory two-lane exit.	Decreases evening peak hour travel time by 4,100 passenger-hours (8%)	Mandatory two-lane off-ramp at Loop 101 in scoping	Adding a third general purpose lane connecting I-10 to Loop 202 in addition to recommended bottleneck projects would reduce travel time by 6,752 passenger-hours (14%)



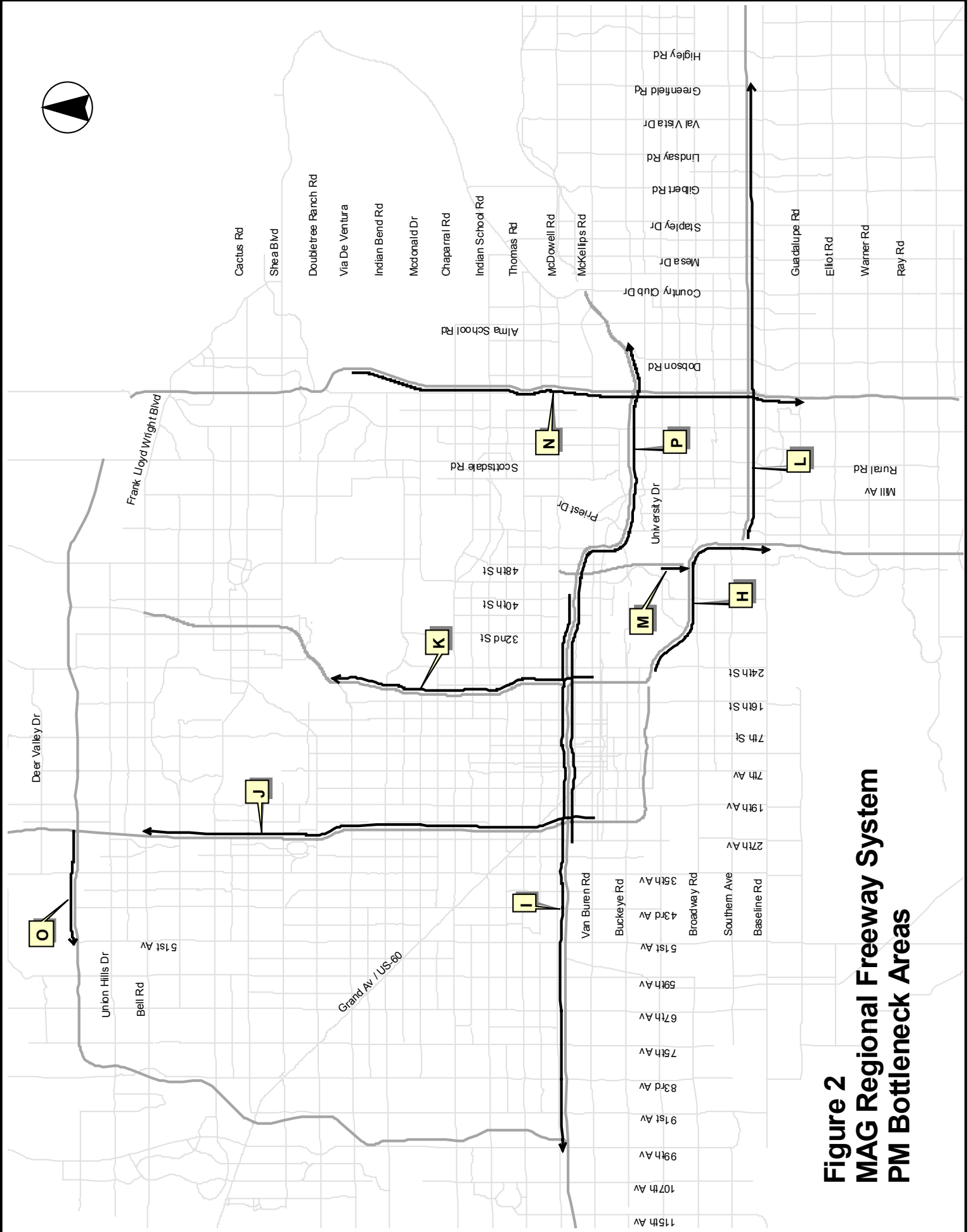
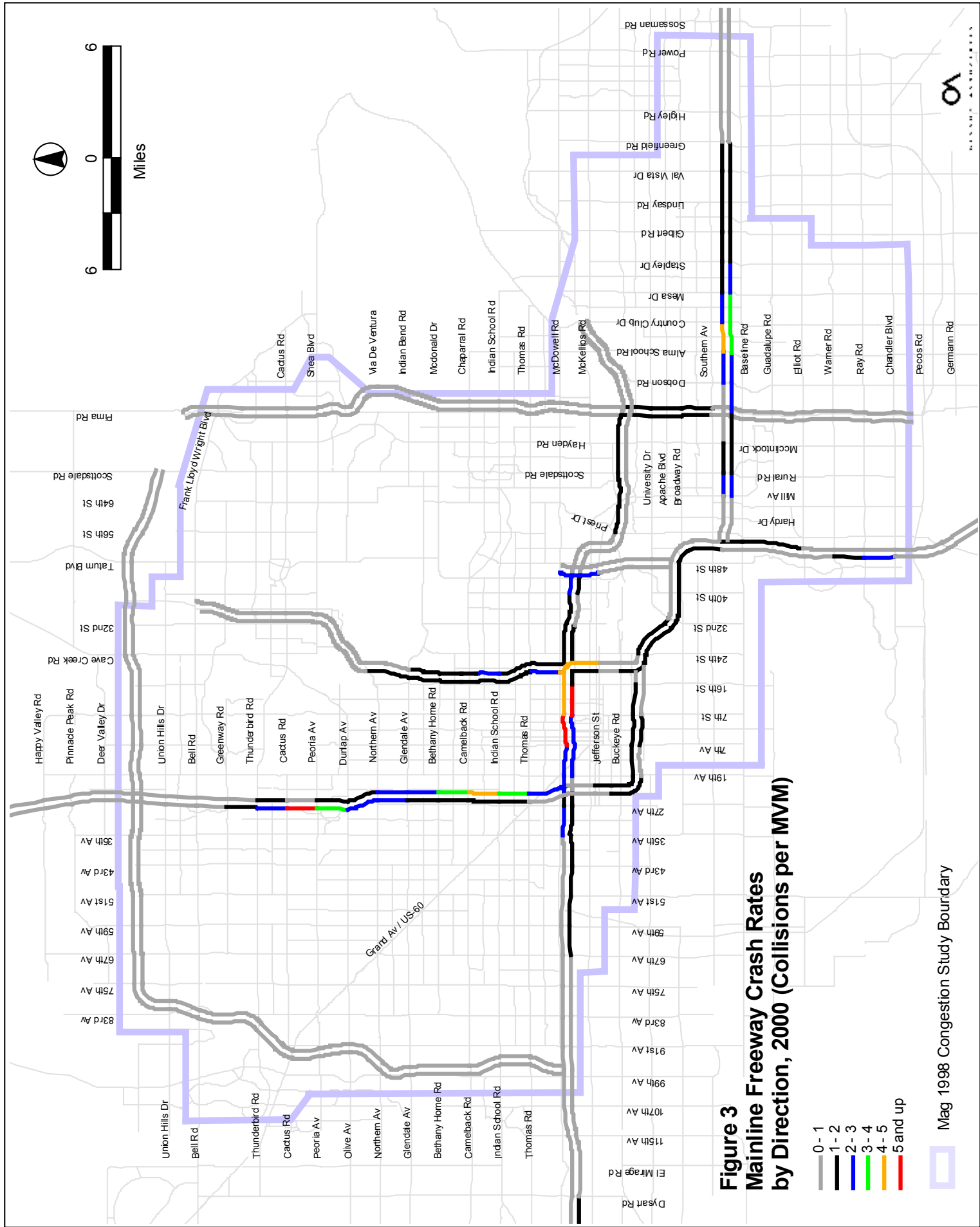


Figure 2
MAG Regional Freeway System
PM Bottleneck Areas



APPENDIX A

APPENDIX A
TABLE OF CONTENTS

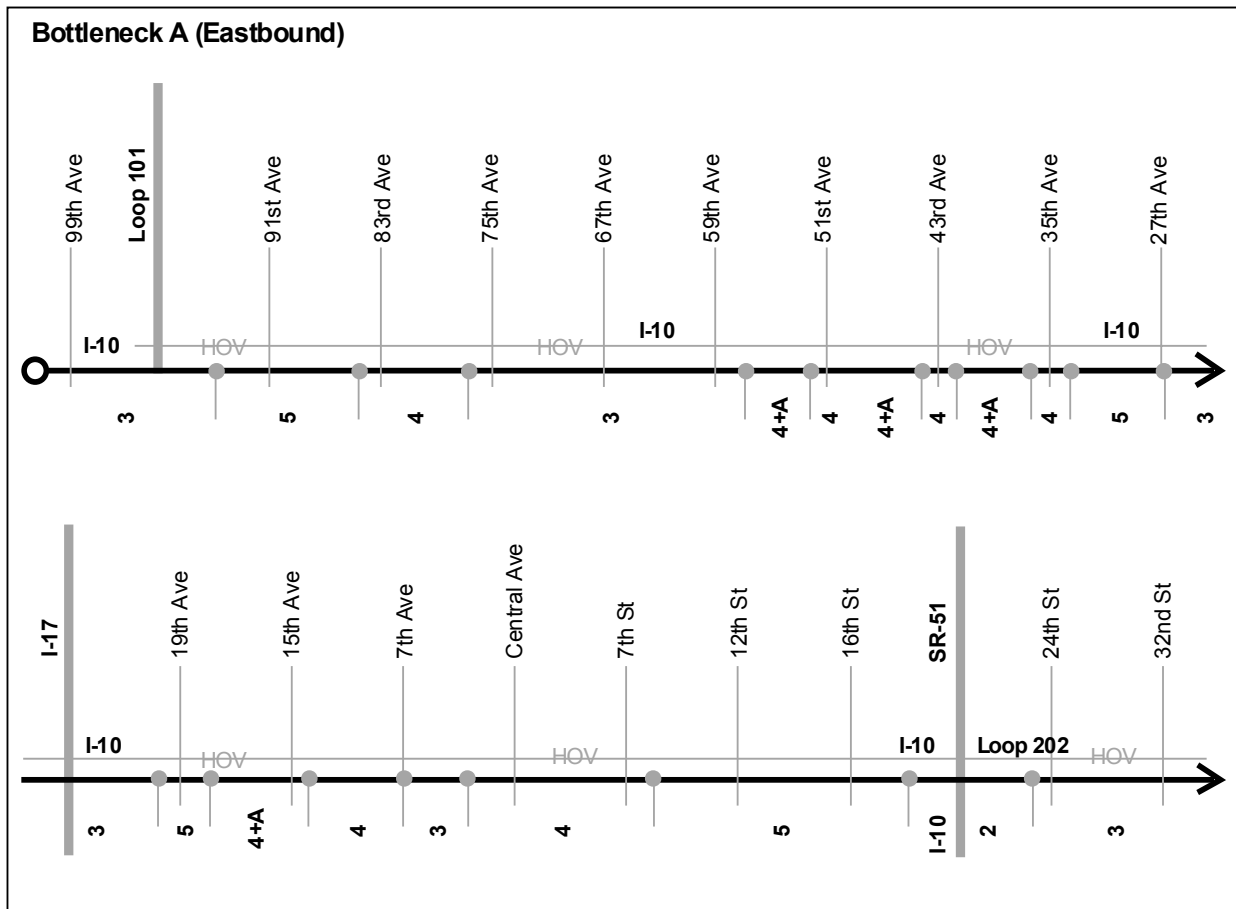
SEGMENT	LOCATION
A	I-10 EASTBOUND: 99 th Avenue to 32 nd Street (on Loop 202) – AM Peak
B	I-10 WESTBOUND: Ray Road to 40 th Street – AM Peak
C	I-17 SOUTHBOUND: Union Hills Drive to Van Buren Street – AM Peak
D	SR-51 SOUTHBOUND: Cactus Road to Van Buren Street – AM Peak
E	US-60 WESTBOUND: Greenfield Road to I-10 – AM Peak
F	LOOP 101 NORTHBOUND: Guadalupe Road to Thomas Road – AM Peak
G	LOOP 202 WESTBOUND: Dobson Road to 35 th Avenue (on I-10) – AM Peak
H	I-10 EASTBOUND: 24 th Street to Baseline Road – PM Peak
I	I-10 WESTBOUND: 40 th Street (on Loop 202) to 99 th Avenue – PM Peak
J	I-17 NORTHBOUND: Van Buren Street (on I-10) to Bell Road – PM Peak
K	SR-51 NORTHBOUND: Van Buren Street (on I-10) to Northern Avenue – PM Peak
L	US-60 EASTBOUND: I-10 to Greenfield Road – PM Peak
M	SR-143 SOUTHBOUND: University Drive to I-10 – PM Peak
N	LOOP 101 SOUTHBOUND: Via de Ventura to Guadalupe Road – PM Peak
O	LOOP 101 WESTBOUND: I-17 to 51 st Avenue – PM Peak
P	LOOP 202 EASTBOUND: 27 th Avenue (on I-10) to Dobson Road – PM Peak

SEGMENT A
I-10 EASTBOUND: 99TH AVENUE TO 32ND STREET (ON LOOP 202)
MORNING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates lane numbers along the A bottleneck segment. Lane numbers are shown below the black line. The letter “A” indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along this bottleneck segment reaches a maximum of 259,000 vehicles (vpd) at the intersection of I-10 and 7th St. The volume at this location during the AM peak hour is 15,500 for General Purpose lanes and 2,400 for HOV lanes. These combined peak hour volumes represent 6.9% of the total daily volume.

Eastbound Traffic Volumes:

The volumes shown in the table below represent eastbound counts along the A bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes

TRAFFIC VOLUMES

Location	AM Peak Hour Total Volume	AM Peak Hour GP Volume	AM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
I-10 / 83 rd Av	6,400	5,500	900	6.6%	4.9%
I-10 / 35 th Av	9,600	8,100	1,500	8.5%	4.4%
I-10 / 7 th Av	8,900	7,400	1,500	7.2%	-----
I-10 / 7 th St	8,000	6,800	1,200	6.6%	1.7%
I-10 / 40 th St	6,300	6,300	600	6.6%	1.0%

CRASH DATA – COLLISION TYPE

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	1008	1.73	699	152	123	34
1999	958	1.55	604	181	135	38
2000	1133	1.74	760	210	128	35
Total	3099	1.67	2063	543	386	107

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	1008	752	254	2	71
1999	958	686	267	5	93
2000	1133	806	326	1	98
Total	3099	2244	847	8	262

The level of service, as observed by Skycomp, is presented on the following page.

On some days but not others, a short zone of eastbound congestion was found on I-10 between I-17 and 7th Avenue; when congested, average estimated speeds along this segment ranged from approximately 40 to 50 mph. Congestion appeared to be caused or exacerbated by the lane drops (5 lanes to 4 and 4 lanes to 3) in the vicinity of 7th Avenue.

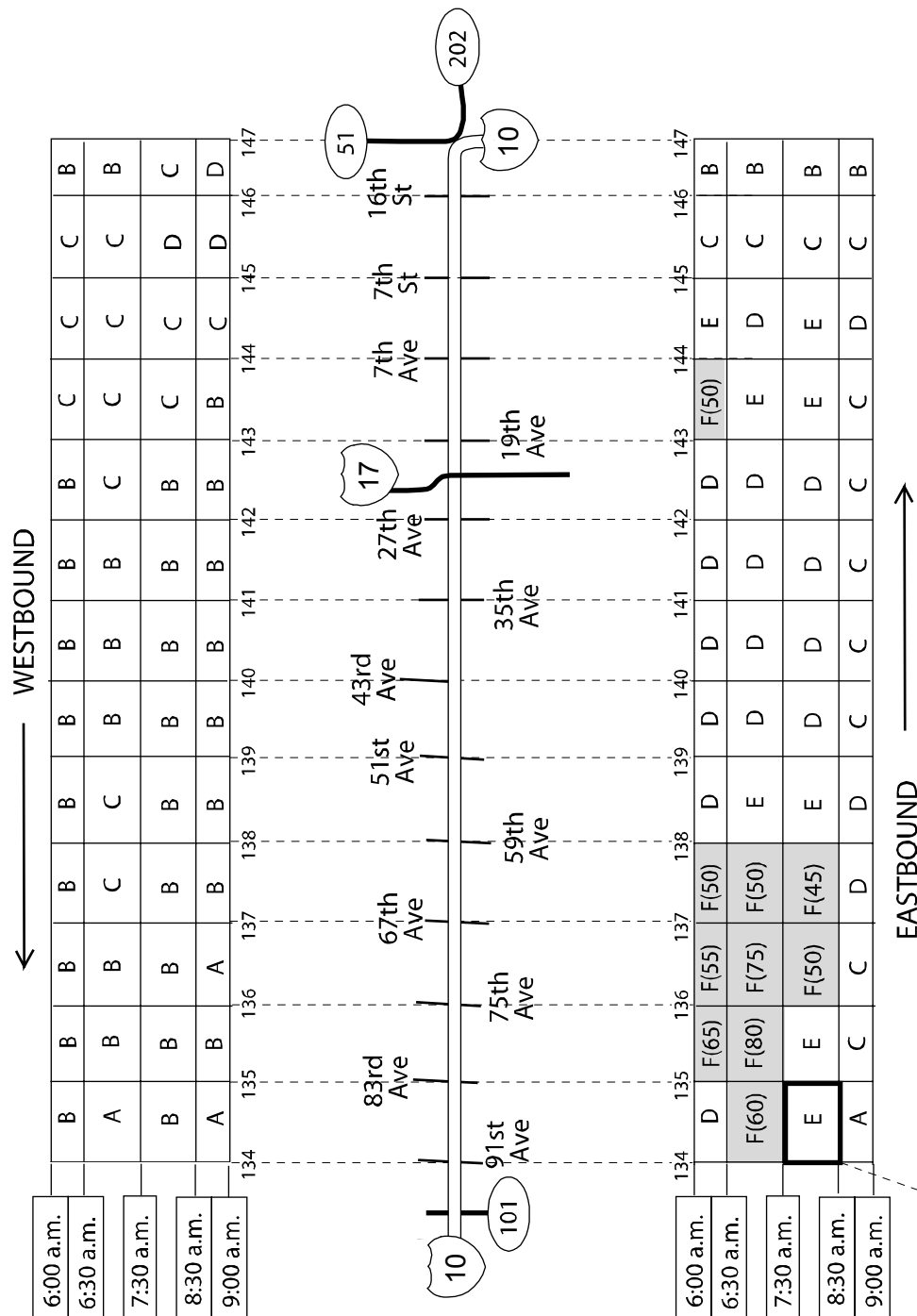
FREO ANALYSIS

Existing Conditions: Existing bottlenecks are occurring at 59th Avenue, 43rd Avenue, 19th Avenue and 7th Avenue.

TIME SLICE	91 st Ave	75th Ave	59th Ave	43rd Ave	35th Ave	19th Ave	7th Ave	7th St	32 nd St	BEGIN TIME																									
1 .	*****BBB									- 5:30																									
2 .	*****BBB									- 5:45																									
3 .	*****									- 6:00																									
4 .	***** **									- 6:15																									
5 .	*****									- 6:30																									
6 .	*****									- 6:45																									
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13 .	***** **									- 8:30																									
14 .	***** ***									- 8:45																									
15 .	*****									- 9:00																									
16 .	*****									- 9:15																									
	01	02	03	04	05	06	07	08	09	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	33	35	36	37	38

BLANK DENOTES UNCONGESTED TRAFFIC.
 ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.
 M DENOTES QUEUED VEHICLES DUE TO MERGING.
 B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.
 P DENOTES A PRIORITY LANE (HOV).

I-10 (Between 91st Ave & Loop 202 / SR 51) Morning - Fall 2001

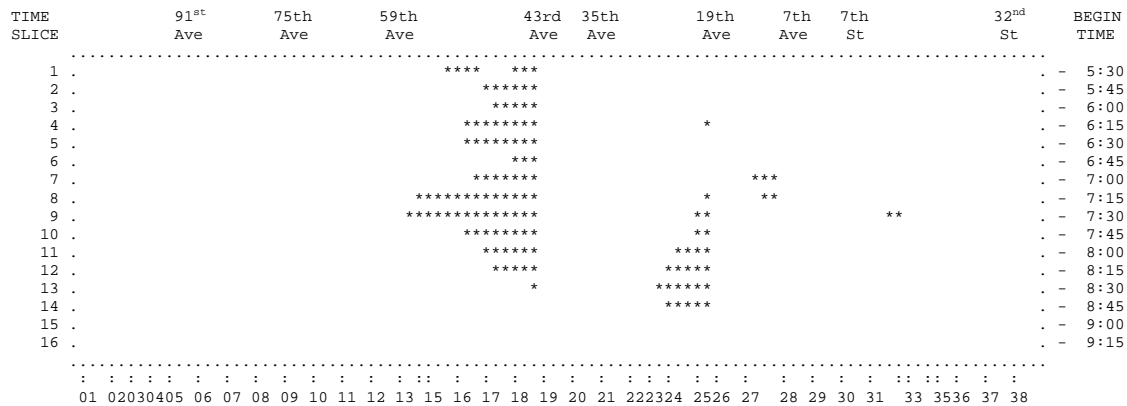


These level-of-service ratings represent the mathematical average of densities, which varied during this hour (congested/not congested); when congested, densities ranged widely, between 90 and 45 pcplpm with corresponding speed estimates of 20 to 50 mph.

Alternative 1: Add a lane from 75th Avenue on-ramp to 59th Avenue on-ramp to increase cross section to 4 lanes, matching east of 59th Avenue

Result: This alternative eliminates the 59th Avenue bottleneck, but increases congestion at the 43rd Avenue and 19th Avenue bottlenecks as the demand at the 59th Avenue bottleneck moves downstream. Overall, freeway travel time decreases 13%.

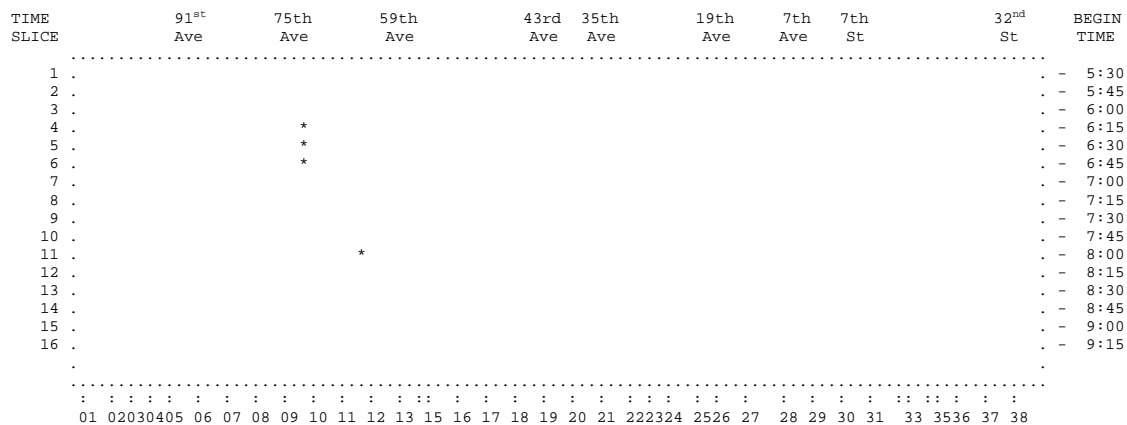
Queue Diagram of Alternative 1 for Segment A:



Alternative 2: Add ramp metering, optimizing between 400 and 900 vehicles per hour.

Result: This alternative eliminates congestion at existing bottlenecks, but causes long queues and delays at on-ramps. Overall freeway travel time increases slightly.

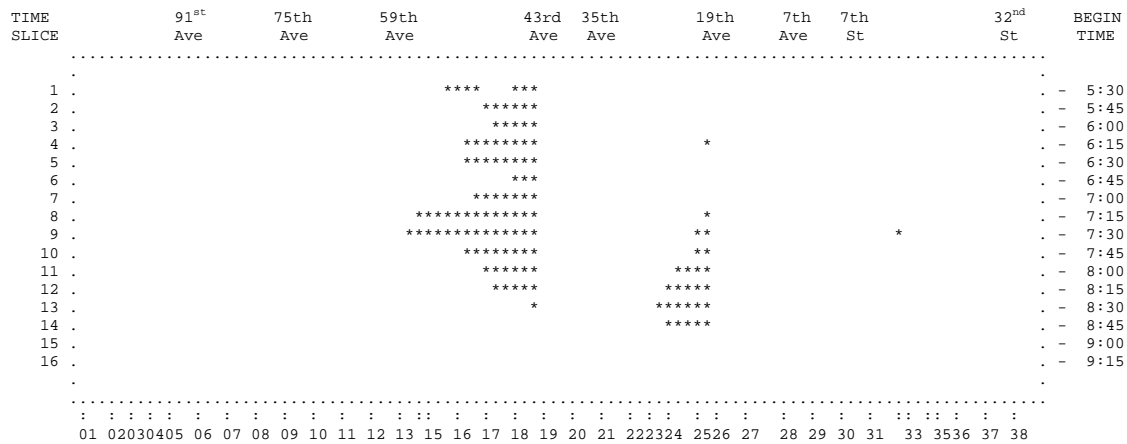
Queue Diagram of Alternative 2 for Segment A:



Alternative 3: Widen the cross-section to 5+1(HOV)+A(auxiliary) from Loop 101 on-ramp to 83rd Avenue and 4+1+A from 83rd Avenue to 59th Avenue. Also add a lane from 7th Avenue to 7th Street to get a 4+1+A cross-section with a lane drop at the 7th Street off-ramp.

Result: This alternative eliminates the 59th Avenue bottleneck, but increases congestion at the 43rd Avenue and 19th Avenue bottlenecks. Overall travel time decreases 13%, the same as for Alternative 1.

Queue Diagram of Alternative 3 for Segment A:



ANALYSIS SUMMARY – SEGMENT A

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	12092	7535	19627	42.6
Alternative 1	9498	7723	17221	54.3
Alternative 2	7815	12156	19972	64.6
Alternative 3	9350	7723	17072	55.1

Conclusions/Recommendations:

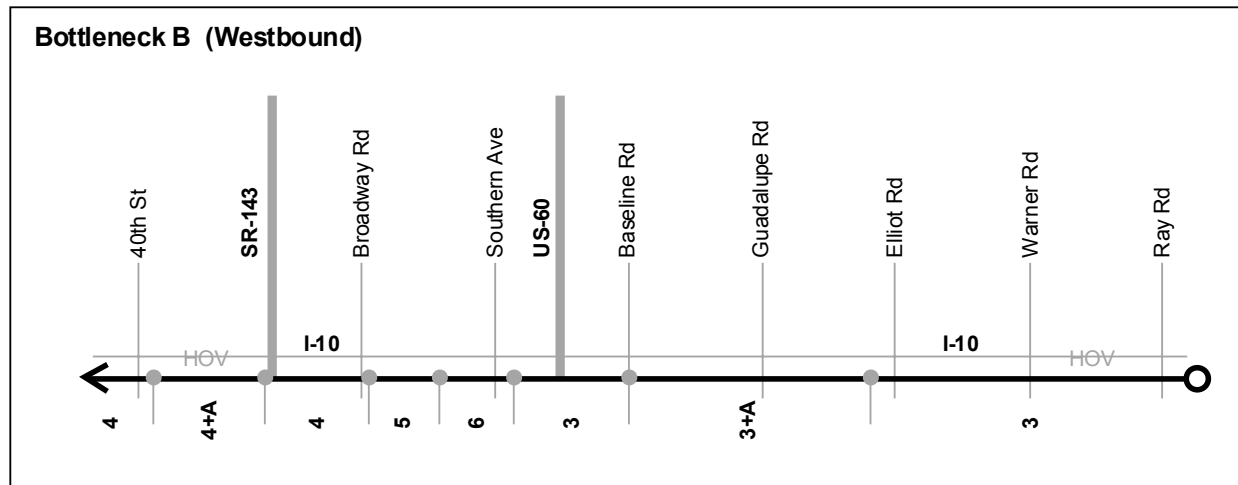
1. The addition of general purpose and auxiliary lanes from Loop 101 to 59th Avenue will significantly reduce existing congestion at the existing bottleneck at 59th Avenue, however, this improvement will also increase demand downstream, creating congestion at 43rd Avenue and 19th Avenue. Increasing the capacity of these two bottlenecks, particularly 19th Avenue, will create added congestion within the downtown section of I-10. As such, keeping the bottlenecks at 43rd Avenue and 19th Avenue in place should be considered as a way to meter traffic demand downstream.
2. Widen the section of I-10 from Loop 101 to 83rd Avenue to a 5+1+A eastbound cross section.
3. Widen the section of I-10 from 83rd Avenue to 59th Avenue to a 4+1+A eastbound cross section.
4. Ramp metering currently exists at most of the on-ramps along the section of I-10 west of I-17. Reducing metering rates accompanied by increased ramp storage, and adding meters to currently un-metered ramps, including the SR 101 to I-10 connection, should be considered.

SEGMENT B **I-10 WESTBOUND: RAY ROAD TO 40TH STREET** **MORNING PEAK PERIOD**

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates the lane configuration along the B bottleneck segment. Lane numbers are shown below the black line. The letter “A” indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along the B bottleneck segment reaches a maximum of 240,000 vehicles (vpd) at the intersection of I-10 and Broadway Rd (the “Broadway Curve”). The volume at this location during the AM peak hour is 18,200, which represents 7.5% of the total daily volume.

Westbound Traffic Volumes:

The volumes shown in the table below represent westbound counts along the B bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	AM Peak Hour Total Volume	AM Peak Hour GP Volume	AM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
I-10 / Ray Rd	5,900	-----	-----	8.3%	-----
I-17 / Warner Rd	6,000	-----	-----	8.9%	2.5%
I-17 / Guadalupe Rd	7,700	-----	-----	7.7%	-----
I-17 / Broadway Rd	12,000	-----	-----	9.8%	-----
I-17 / 32nd St	9,700	-----	-----	9.3%	3.4%

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	255	1.04	153	39	48	15
1999	277	1.08	167	45	48	17
2000	319	1.18	189	61	53	16
Total	851	1.10	509	145	149	48

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	255	183	70	2	26
1999	277	202	75	0	28
2000	319	229	90	0	38
Total	851	614	235	2	92

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

Observations: During most observations, an extended zone of northbound congestion was found in I-10 between Ray Road and Southern Avenue; average estimated speeds typically range from approximately 10 to 30 mph. Factors contributing to the congestion were 1) the lane drop [4 lanes to 3] at Baseline Road and 2) traffic entering at US-60. Traffic flow typically improved north of Southern Avenue, where the road widened from 3 to 5 lanes.

During the peak period, northbound congestion was found in the weaving lanes (separated by Jersey barrier) between Baseline Road and US-60: when congested, approximately 40 to 60 vehicles were queued on the ramp to I-10 (one lane).

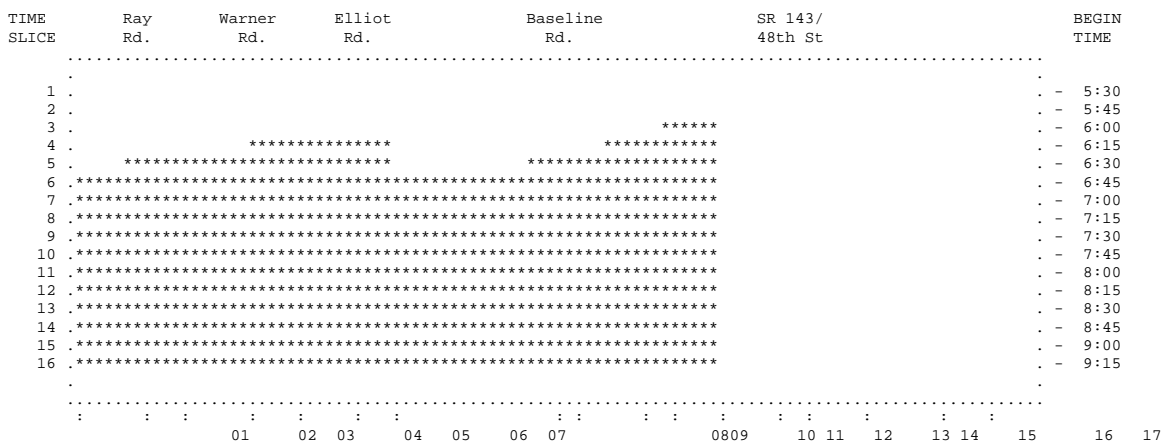
Density Data: (no data collected after 9:00 am) Level of Service F (density greater than 45 vehicles per lane-mile) between Southern Avenue and Ray Road between 6:30 and 9:00 am.

FREQ ANALYSIS

Segment B: I-10 WB; Ray Road to 40th Street; 5:30 to 9:30 AM

Existing Conditions: Existing bottlenecks are occurring at Elliot Road and Broadway Road. Congestion extends from Broadway Road to south of Ray Road. The bottleneck at Broadway Road is due to heavy merging and weaving between the I-10/US-60 junction and SR-143.

Queue Diagram of Existing Conditions for Segment B:



Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

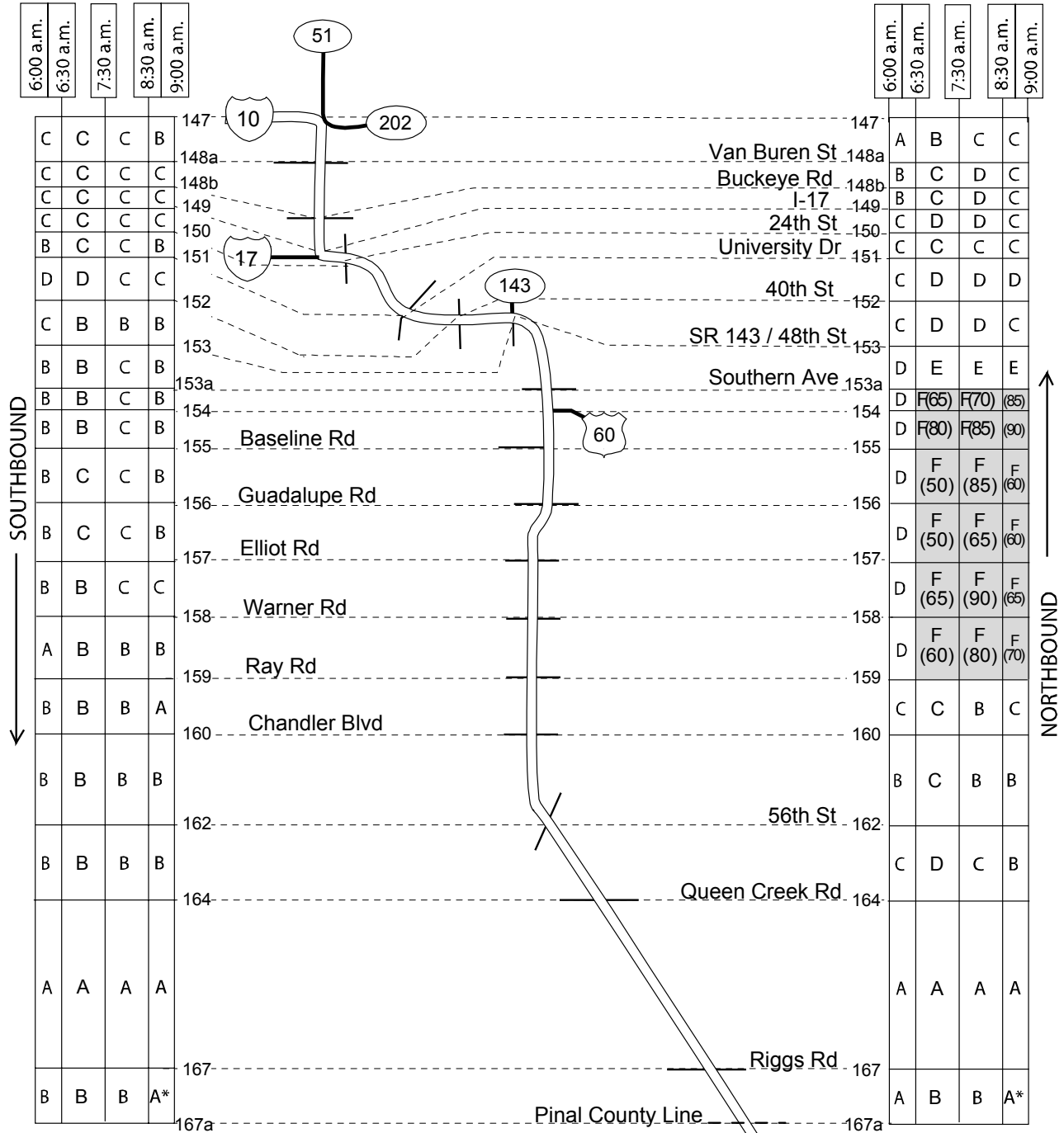
ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

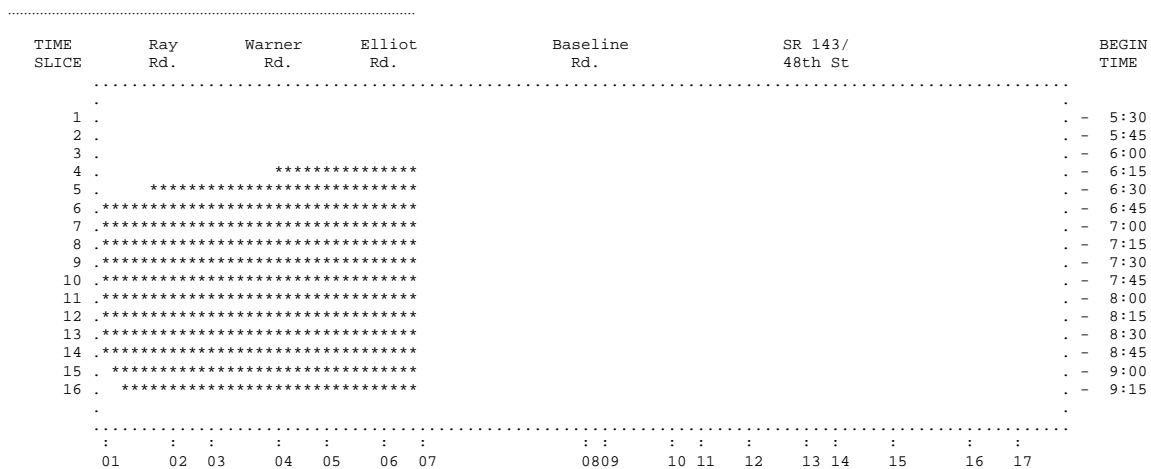
I-10
(Between Loop 202 / SR 51 & Chandler Blvd)
Morning - Fall 2001



Alternative 1: Add a collector-distributor road from Baseline Road to SR-143. The collector-distributor road will remove traffic headed to Broadway Road and SR-143 from the I-10/US-60 merge/weave area.

Result: This alternative eliminates the congestion at the Broadway Road bottleneck, however the bottleneck at Elliot Road remains. Overall freeway travel time decreases 26%.

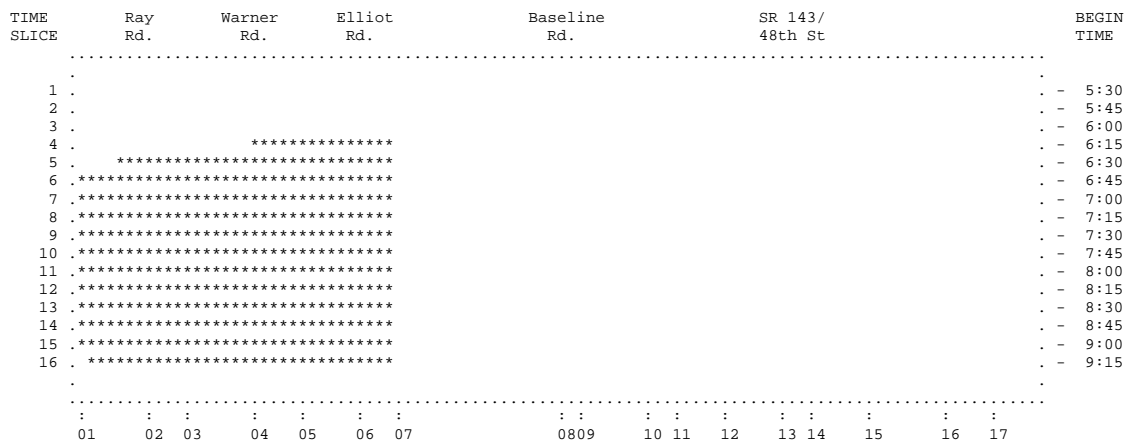
Queue Diagram of Alternative 1 for Segment B:



Alternative 2: Add a collector –distributor road from Baseline Road to 40th Street.

Result: Similar to the results of Alternative 1, this alternative eliminates the congestion at the Broadway Road bottleneck, but does not improve conditions at Elliot Road. Overall, freeway travel time decreases 30%.

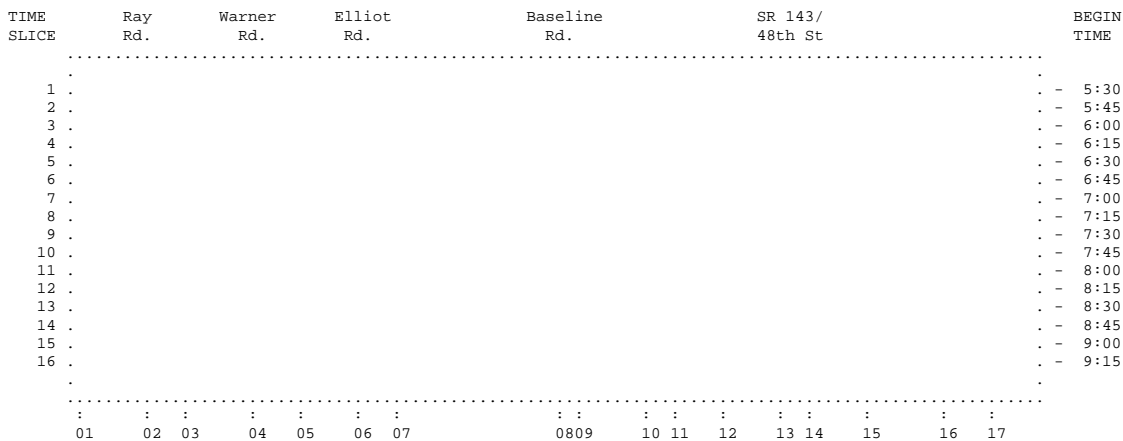
Queue Diagram of Alternative 2 for Segment B:



Alternative 3: Add ramp metering at 900 vehicles per hour. This does not include either of the collector-distributor road alternatives.

Result: This alternative eliminates congestion at both bottlenecks, but causes significant queues and delays at all on-ramps from Ray Road. Overall freeway travel time increases slightly, not including delays caused to arterial traffic at ramp junctions.

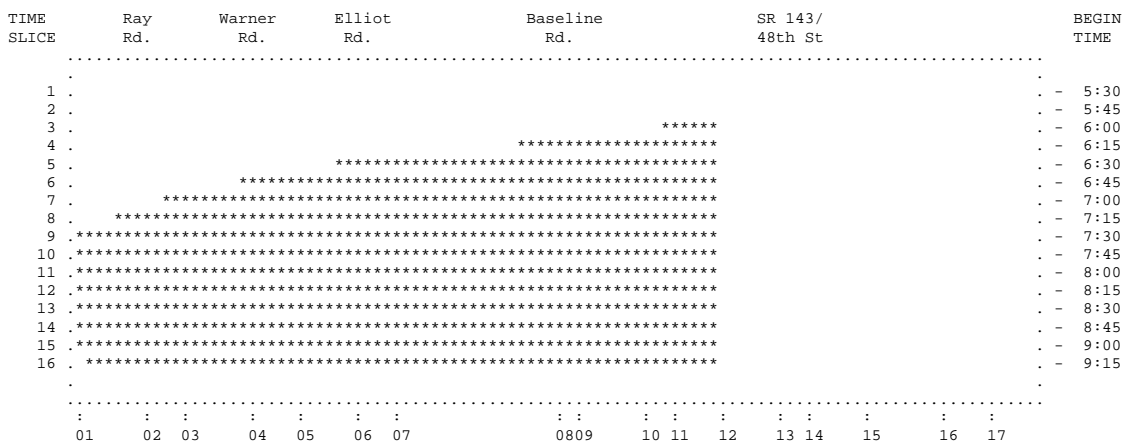
Queue Diagram of Alternative 3 for Segment B:



Alternative 4: Widen the mainline cross section to 4+1+A from Chandler Boulevard to the US-60 interchange. This alternative does not include either collector-distributor road option.

Result: This alternative reduces the congestion at Elliot Road, but congestion from the bottleneck at Broadway Road still extends south of Ray Road. Overall freeway travel time increases 5% since demand from Elliot Road moves downstream.

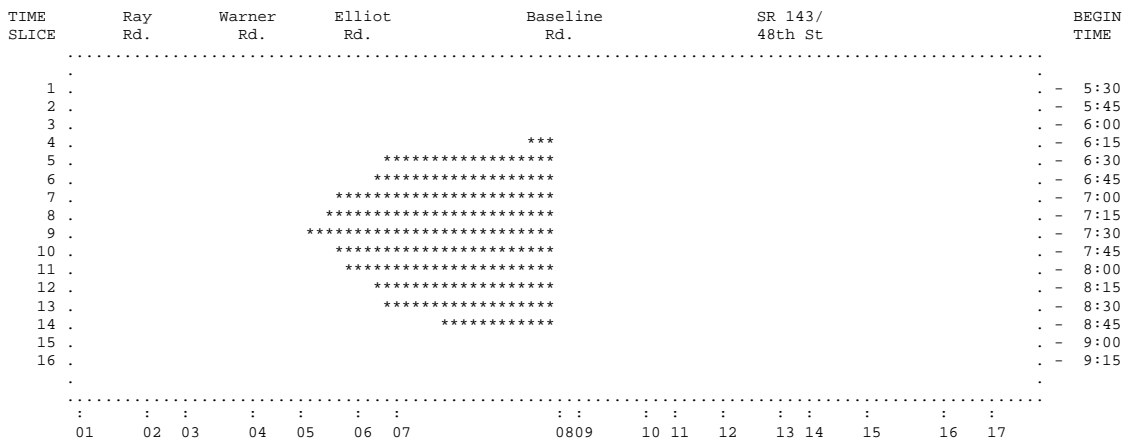
Queue Diagram of Alternative 4 for Segment B:



Alternative 5: Widen the mainline cross section to 4+1+A from Chandler Boulevard to the US-60 interchange. Also include the collector-distributor road from Baseline Road to the SR-143 interchange.

Result: This alternative eliminates congestion at the Elliot Road and Broadway Road bottlenecks, however a new bottleneck occurs at Baseline Road. Overall freeway travel time decreases 33%.

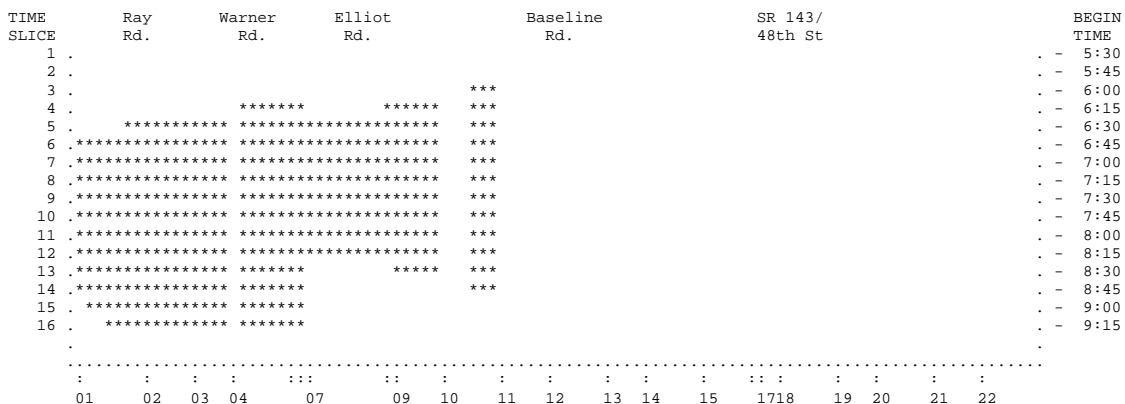
Queue Diagram of Alternative 5 for Segment B:



Alternative 6: This alternative addresses the impact of eliminating the existing bottleneck on WB US-60, which will increase demand at the WB I-10/US-60 junction. The analysis of this alternative assumed that the collector-distributor road from Baseline Road to SR-143 (Alt. 1) will be constructed on I-10.

Result: The higher volume of traffic entering I-10 from US-60 will result in higher overall travel time, however the majority of congestion will continue to be contained on the US-60 ramp as it is today. Overall, freeway travel time will be 30% lower than existing conditions, as compared to 45% lower if the bottleneck on US-60 is not relieved.

Queue Diagram of Alternative 6 for Segment B:



ANALYSIS SUMMARY – SEGMENT B

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	9639	23415	33055	23.9
Alternative 1	6651	17848	24499	31.5
Alternative 2	6979	15545	22524	32.2
Alternative 3	2879	30558	33437	67.4
Alternative 4	12022	22746	34768	19.8
Alternative 5	4445	17920	22364	51.8

Conclusions/Recommendations:

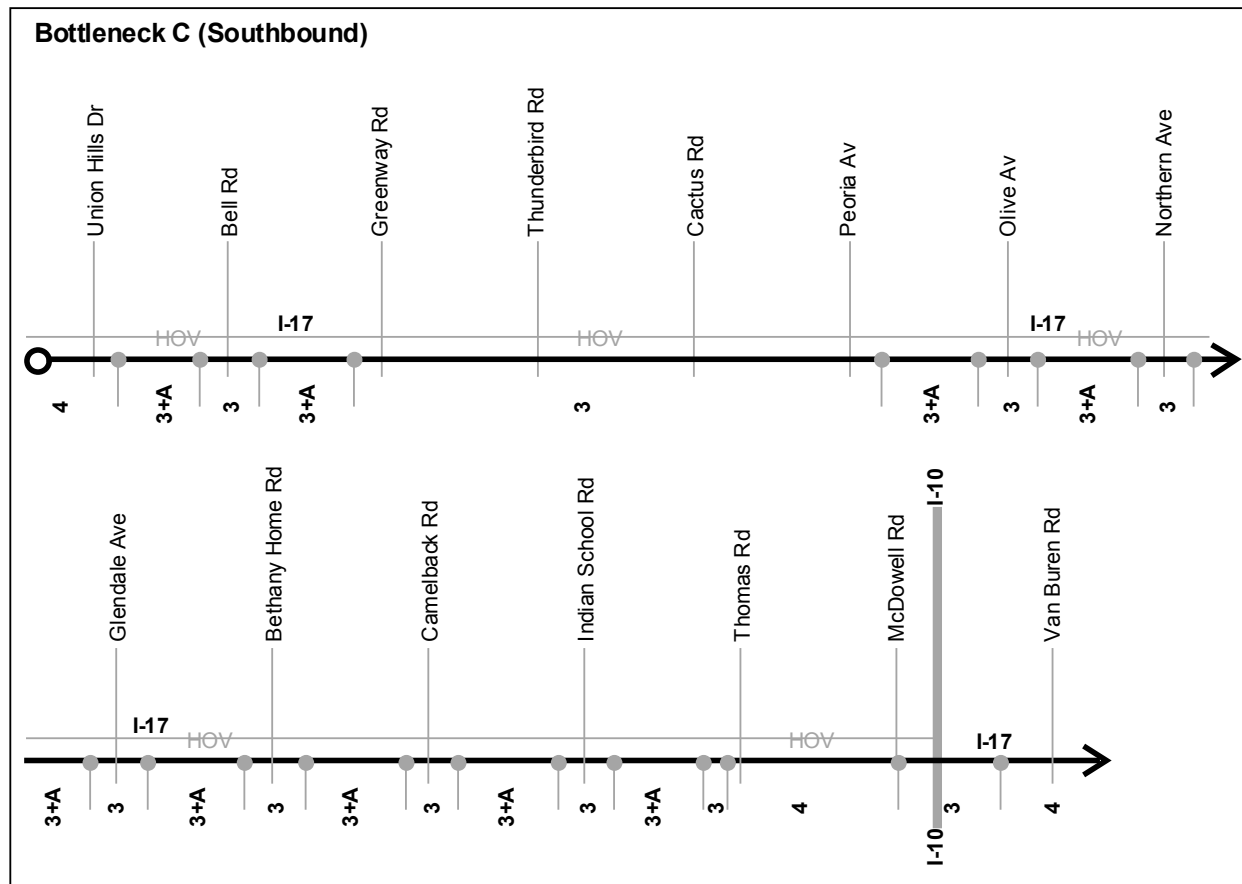
1. The addition of a collector-distributor road from Baseline Road to SR-143 will eliminate much of the merging/weaving at the I-10/US-60 interchange, thereby increasing the capacity of the segment between the interchange and SR-143. The on-going collector-distributor road study will provide a detailed assessment of the impacts on mainline traffic flow, collector-distributor road operations, and access.
2. Widening the section of I-10 from Chandler Boulevard to US-60 to 4+1+A will alleviate congestion at the Elliot Road bottleneck, however, the increased demand downstream will create congestion at Baseline Road. This improvement should be evaluated as part of the collector-distributor road study.
3. Ramp metering should be installed at all on-ramps east of the I-10/US-60 interchange. Additional ramp storage should be added, if possible, in order to allow for reduced metering rates. A systems approach should be taken towards developing and optimizing ramp metering rates at each ramp. A uniform rate (i.e.-900 vph) at each ramp will not provide optimum benefits to traffic flow.
4. Eliminating the bottlenecks on WB US-60, which currently limits the volume of traffic that enters I-10, will impact traffic flow on I-10. However, traffic on the US-60 ramp will experience the majority of the delay and ramp backups will likely occur.

SEGMENT C **I-17 SOUTHBOUND: UNION HILLS DRIVE TO VAN BUREN STREET** **MORNING PEAK PERIOD**

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates lane numbers along the C bottleneck segment. Lane numbers are shown below the black line. The letter “A” indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along this bottleneck segment reaches a maximum of 208,000 vehicles (vpd) at the intersection of I-17 and Indian School Rd. The volume at this location during the AM peak hour is 13,100 for General Purpose lanes and 1,400 for HOV lanes. These combined peak hour volumes represent 6.3 percent of the total daily volume.

Southbound Traffic Volumes:

The volumes shown in the table below represent southbound counts along the C bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	AM Peak Hour Total Volume	AM Peak Hour GP Volume	AM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
I-17 / Thunderbird Rd	6,700	5,800	900	7.3%	2.4%
I-17 / Peoria Av	7,100	-----	-----	6.9%	-----
I-17 / Glendale Av	8,000	6,500	1,500	7.6%	1.3%
I-17 / Highland Av	8,100	7,000	1,100	7.6%	1.6%
I-17 / Van Buren St	6,200	-----	-----	9.2%	-----

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	963	2.0	738	90	107	28
1999	869	1.77	623	107	111	28
2000	1161	2.31	828	165	137	31
Total	2993	2.03	2189	362	355	87

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	963	684	277	2	58
1999	869	623	244	2	50
2000	1161	796	365	0	80
Total	2993	2103	886	4	188

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

Observations: During the peak period, an extended zone of southbound congestion was found on I-17 between Union Hills Drive and Camelback Road; average speeds along this segment typically ranged from approximately 25 to 45 mph. Congestion appeared to be caused or exacerbated by weaving and merging associated with the interchanges along this corridor.

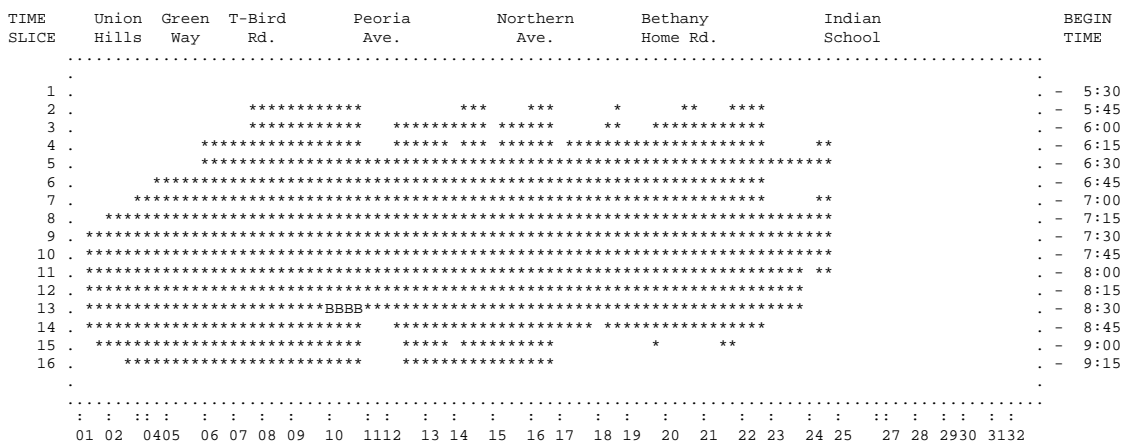
Density Data: Level of Service F (density greater than 45 vehicles per lane-mile) between Bell Road and Greenway Road between 7:30 and 8:30 am; between Greenway Road and Thunderbird Road between 6:30 and 8:30 am; between Thunderbird Road and Cactus Road between 6:30 and 9:00 am; between Cactus Road and Northern Avenue between 6:30 and 8:30 am; between Northern Avenue and Glendale Road between 6:00 and 6:30 am, and again between 7:30 and 8:30; and between Glendale Avenue and Camelback Road between 6:30 and 7:30 am.

FREQ ANALYSIS

Segment C: I-17 SB; Union Hills Drive to Van Buren Street; 5:30 to 9:30 am

Existing Conditions: On this section of I-17, multiple bottlenecks currently exist. Accommodating additional capacity will be costly since a portion of the freeway is depressed, existing right-of-way is limited, and the adjacent properties are well developed.

Queue Diagram of Existing Conditions for Segment C:



Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

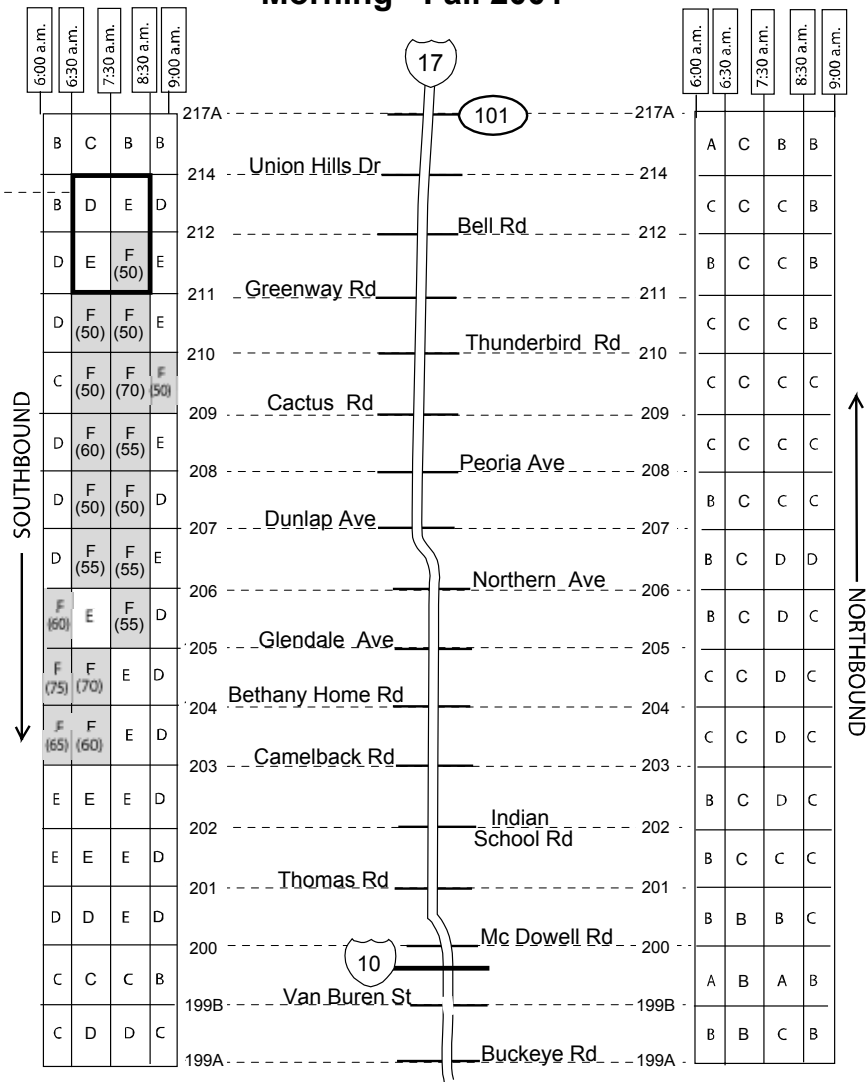
M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

I-17 (Between Loop 101 & I-10) Morning - Fall 2001

These level-of-service ratings represent the mathematical average of densities, which varied from day-to-day (congested/not congested); when congested, densities typically ranged between 60 and 50 pcplpm with corresponding speed estimates of 35 to 45 mph.



LEVEL-OF-SERVICE LEGEND:

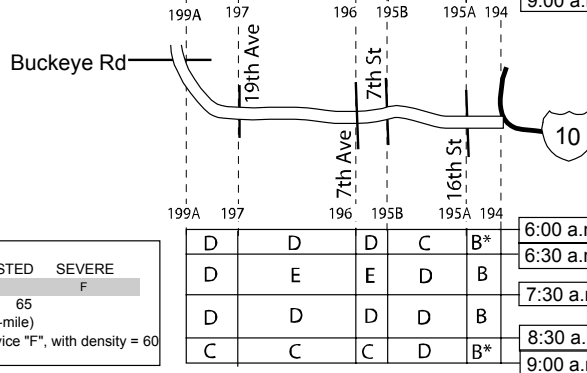
LIGHT	MODERATE	HEAVY	CONGESTED	SEVERE
A	B	C	D	E
0	10	20	30	45
				65
				F

Density scale (cars per lane-mile)

Note: F (60) in the tables means level-of-service "F", with density = 60

B	B	C	C	B*
C	C	C	C	B
C	C	C	C	C
C	B	B	C	C

6:00 a.m.
6:30 a.m.
7:30 a.m.
8:30 a.m.
9:00 a.m.

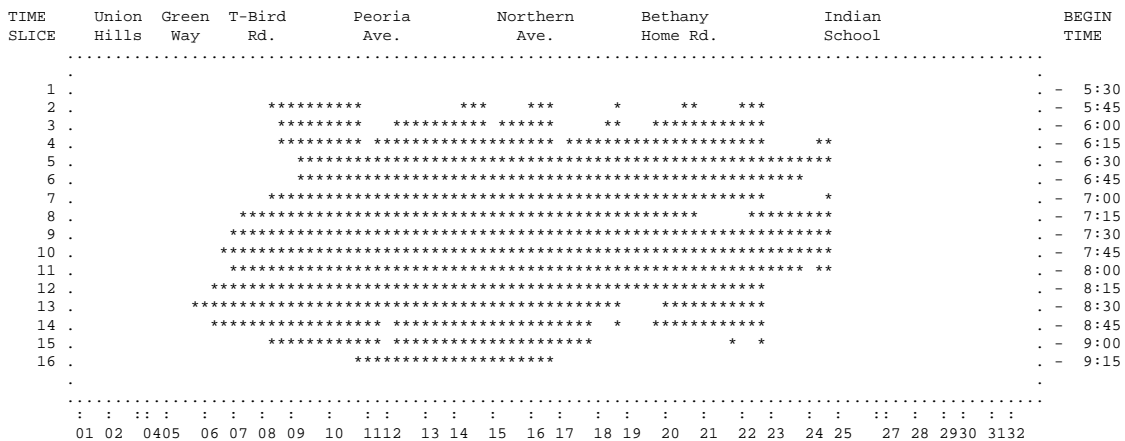


* Projected

Alternative 1: Add ramp metering at 900 vehicles per hour throughout the segment. This includes changing any existing HOV meter bypass lanes into dual meter ramps. Note that ramp metering is already in place at each on-ramp along this segment.

Result: Mainline congestion is reduced between Union Hills Drive and Thunderbird Road increased queuing at on-ramps will occur. Overall freeway travel time increases slightly.

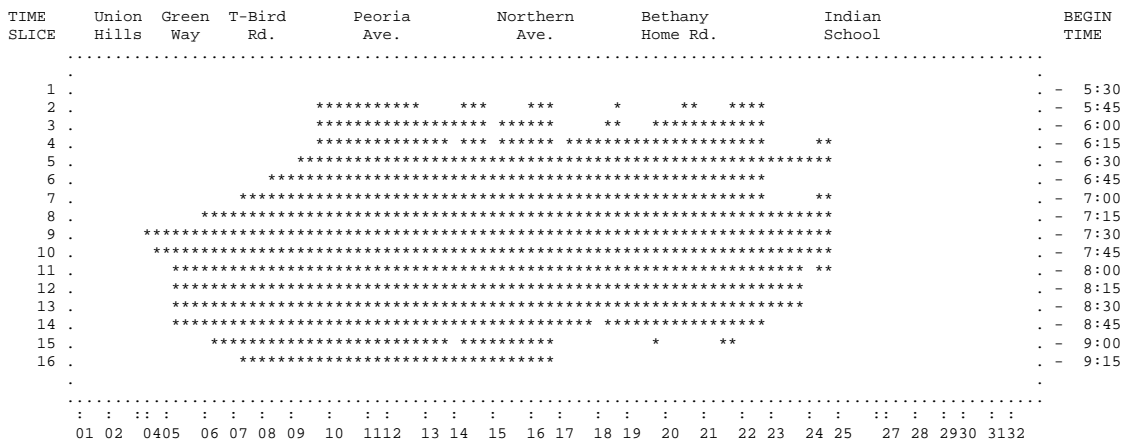
Queue Diagram of Alternative 1 for Segment C:



Alternative 2: Add auxiliary lanes between Union Hills Drive and Peoria Avenue and between McDowell Road and Thomas Road.

Result: Slightly reduces the duration of congestion between Union Hills Drive and Cactus Road. Overall freeway travel time decreases 6%.

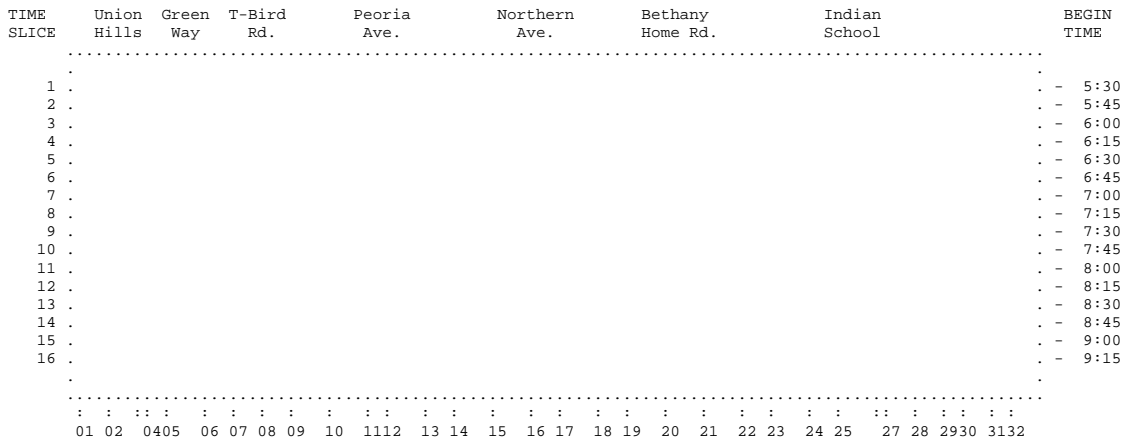
Queue Diagram of Alternative 2 for Segment C:



Alternative 3: Add a general purpose lane from Union Hills Drive to McDowell Road, keeping the existing HOV lane in operation.

Result: This is an extremely expensive alternative, but it will eliminate existing congestion. Overall, freeway travel time decreases 21%.

Queue Diagram of Alternative 3 for Segment C:



ANALYSIS SUMMARY – SEGMENT C

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	14029	9043	23072	27.9
Alternative 1	10861	13110	23971	35.8
Alternative 2	12649	9039	21688	31.2
Alternative 3	6082	12351	18433	67.9

Conclusions/Recommendations:

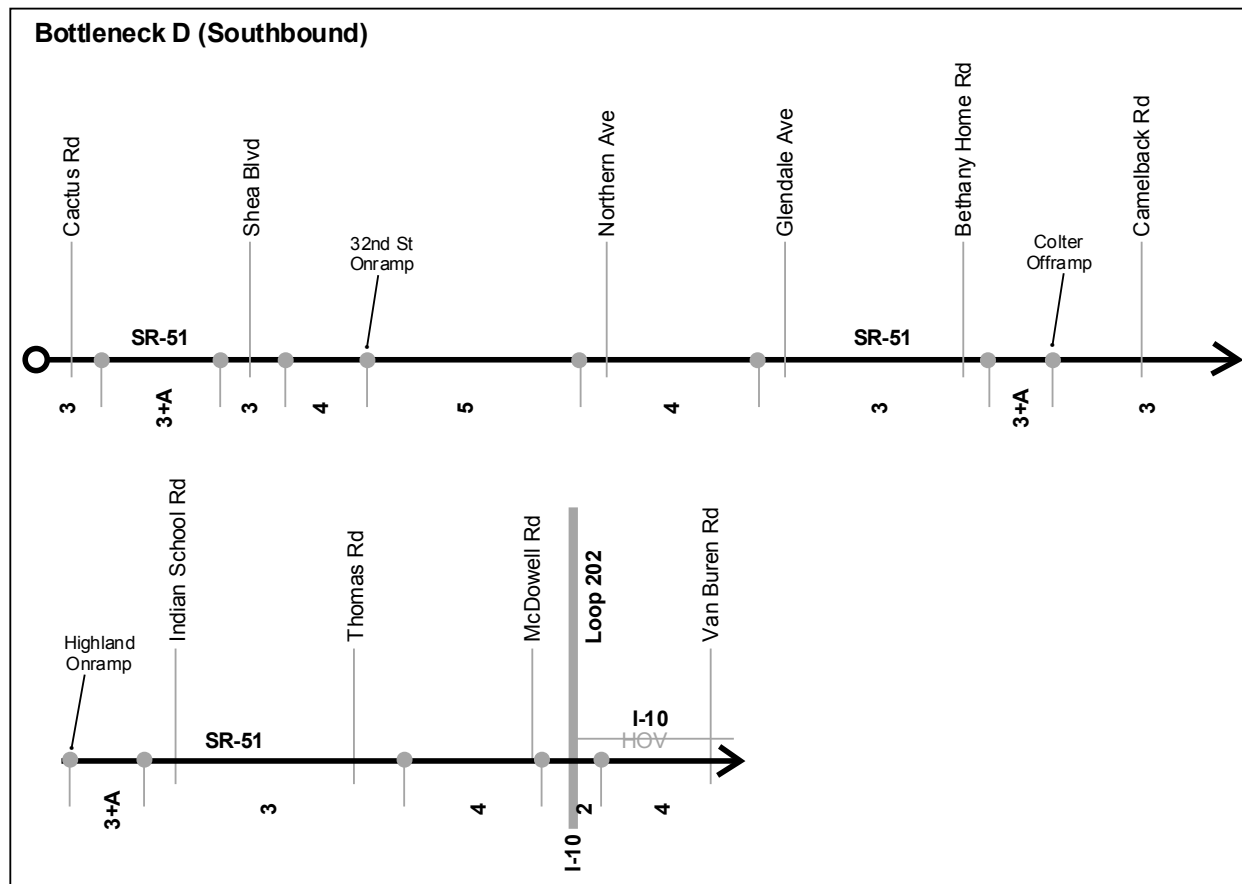
1. Short of adding a fourth general purpose lane, the addition of auxiliary lanes north of Union Hills Drive or stricter operation of ramp metering will not significantly reduce existing congestion.
2. Additional capacity along this section of the I-17 corridor could be achieved by elevating the existing HOV lanes on a structure. Space for light-rail could also be provided on the structure. The existing HOV lane could then be converted to a general purpose lane. However, eliminating the bottlenecks along I-17 will significantly increase demand downstream at the I-10/I-17 interchange and the downtown section of I-10.

SEGMENT D
SR-51 SOUTHBOUND: CACTUS ROAD TO VAN BUREN STREET (ON I-10)
MORNING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates lane numbers along the D bottleneck segment. Lane numbers are shown below the black line. The letter “A” indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along the D bottleneck segment reaches a maximum of 160,000 vehicles (vpd) at the intersection of I-10 and Van Buren St (the southernmost end of the segment). The volume at this location during the AM peak hour is 11,700, which represents 7.3 percent of the total daily volume.

Southbound Traffic Volumes:

The volumes shown in the table below represent southbound counts along the D bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	AM Peak Hour Total Volume	AM Peak Hour GP Volume	AM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
SR- 51 / Shea Blvd	7,200	-----	-----	12.7%	-----
SR- 51 / Via de Ventura	7,600	-----	-----	12.0%	-----
SR- 51 / Highland Av	6,700	-----	-----	10.2%	-----
SR- 51 / Thomas Rd	6,800	-----	-----	7.8%	-----
I-10 / Van Buren St	5,700	5,400	300	7.3%	-----

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	332	1.17	215	39	66	12
1999	350	1.21	243	49	48	10
2000	404	1.39	260	55	67	22
Total	1086	1.26	718	143	181	44

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	332	238	94	0	7
1999	350	252	95	3	5
2000	404	293	109	2	5
Total	1086	783	298	5	17

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

Observations: During the peak period, southbound congestion was typically found on SR-51 between Northern Avenue and Thomas Road; average speeds typically ranged from approximately 35 to 45 mph. Factors contributing to the congestion were 1) the lane drop [4 lanes to 3] at Glendale Avenue and 2) weaving and merging associated with the interchanges along this corridor. On some days but not others, the tail of the queue extended back to the vicinity of Cactus Road.

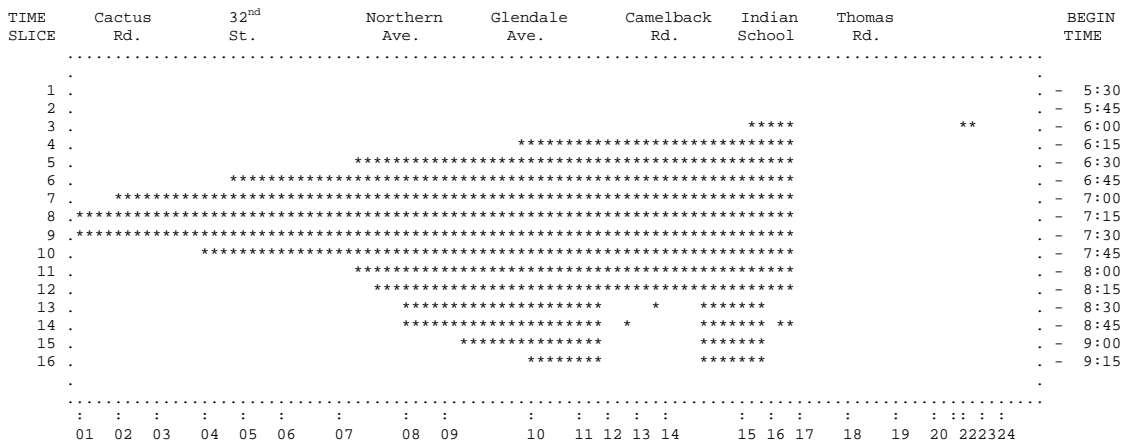
Density Data: (not surveyed before 6:30 am) Level of Service F (density greater than 45 vehicles per lane-mile) between Northern Avenue and Bethany Home Road between 6:30 and 8:30 am, and between Bethany Home Road and Thomas Road between 7:30 and 8:30 am.

FREQ ANALYSIS

Segment D: SR-51 SB; Cactus Road to Van Buren Street; 5:30 to 9:30 am.

Existing Conditions: Bottlenecks currently occur at Bethany Home Road, Indian School Road and between Indian School and Thomas Roads. The resulting congestion extends from Osborn Road to Cactus Road. The bottlenecks, particularly on the south end, are partially a result of the roadway's horizontal and vertical alignments that reduce its free-flow speed and capacity.

Queue Diagram of existing conditions for Segment D:



Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

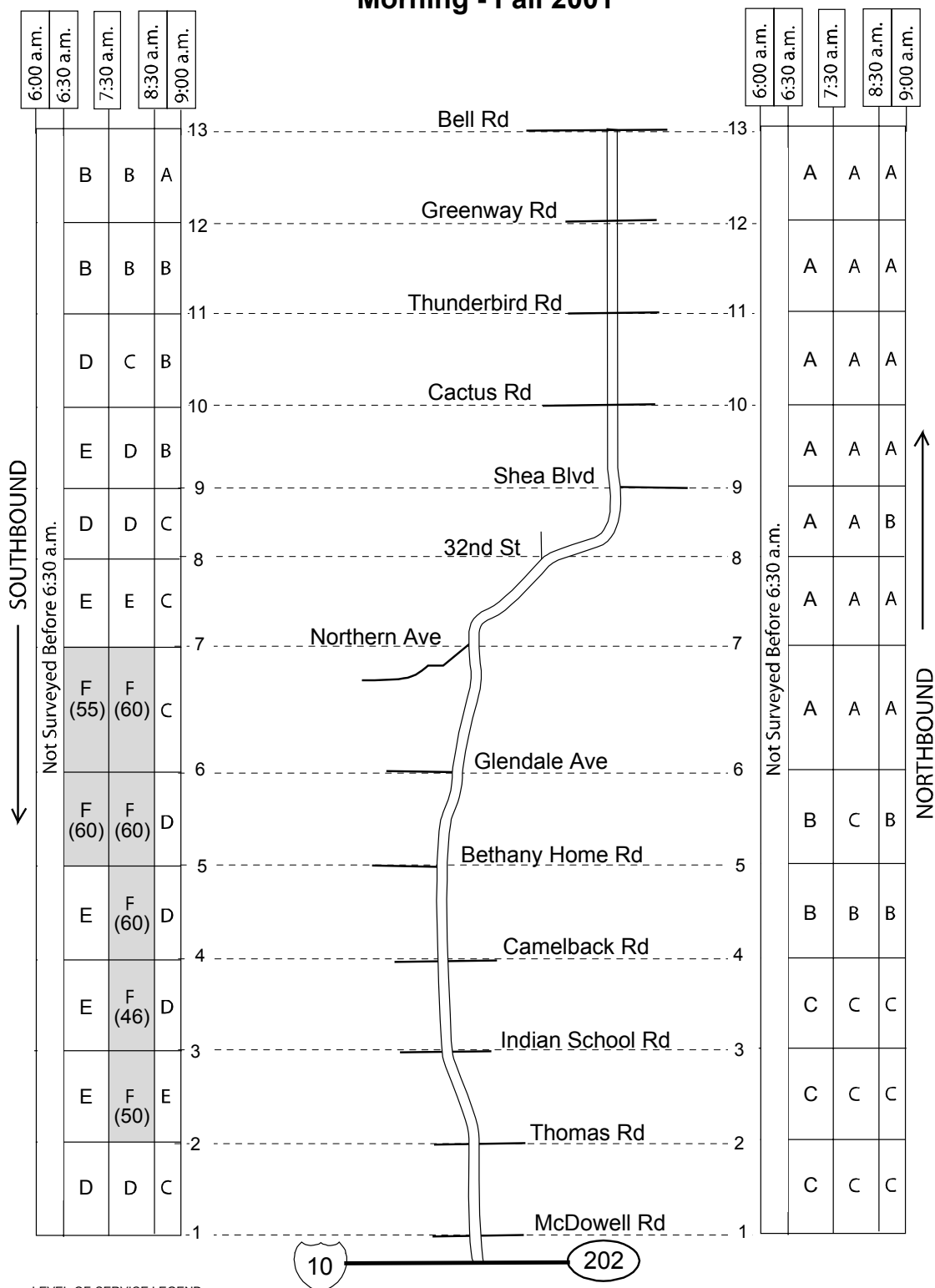
ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

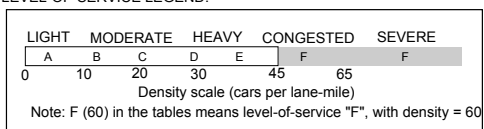
B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

SR 51 Morning - Fall 2001



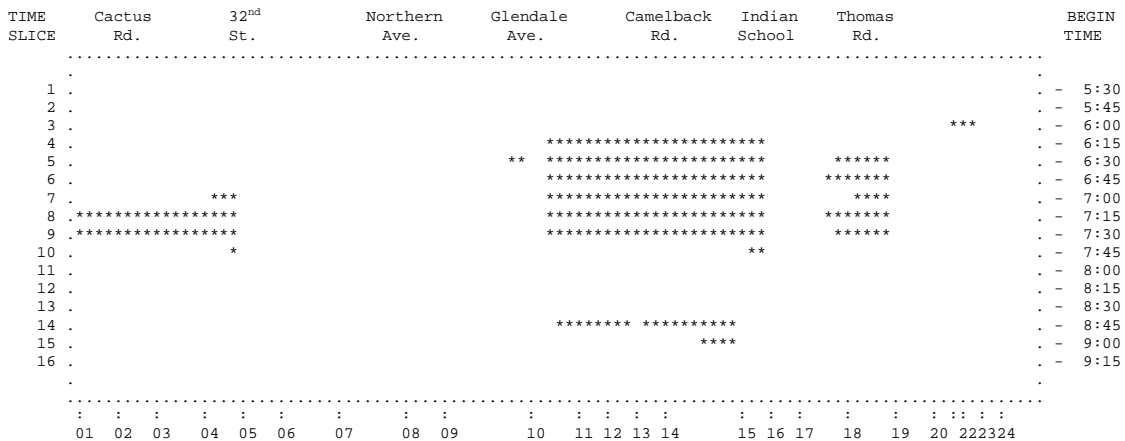
LEVEL-OF-SERVICE LEGEND:



Alternative 1: Add auxiliary lanes between Glendale Road and Bethany Home Road, and between Indian School Road and Thomas Road.

Result: This alternative reduces congestion at the bottleneck at Bethany Home Road and also benefits the bottleneck at Indian School Road. Previously hidden bottlenecks appear at 32nd Street and Thomas Road. Overall freeway travel time decreases 8%.

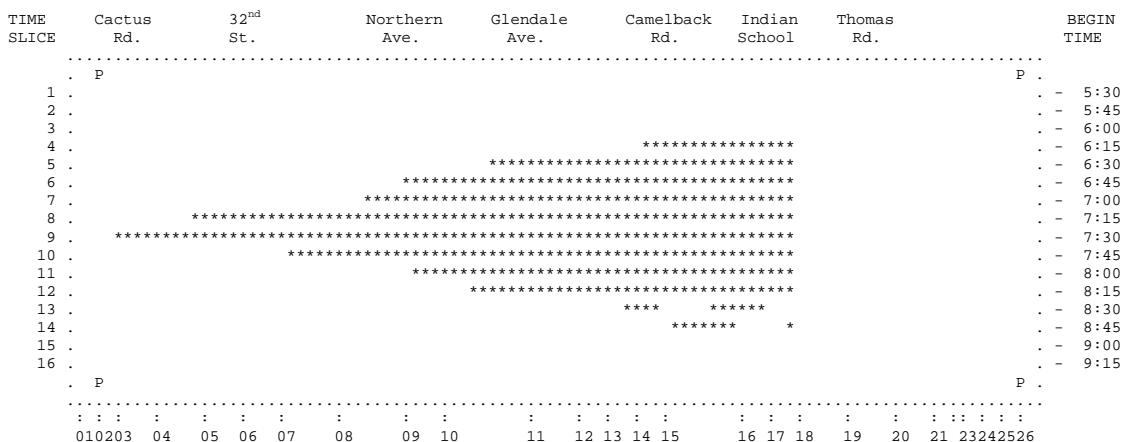
Queue Diagram of Alternative 1 for Segment D:



Alternative 2: Add an HOV lane. For modeling purposes, it was assumed that 10% of the traffic contains 2 or 3+ passengers and thus can use the HOV lane. This alternative does not include the addition of auxiliary lanes.

Result: This alternative decreases the duration of congestion. Overall, freeway travel time decreases 8%.

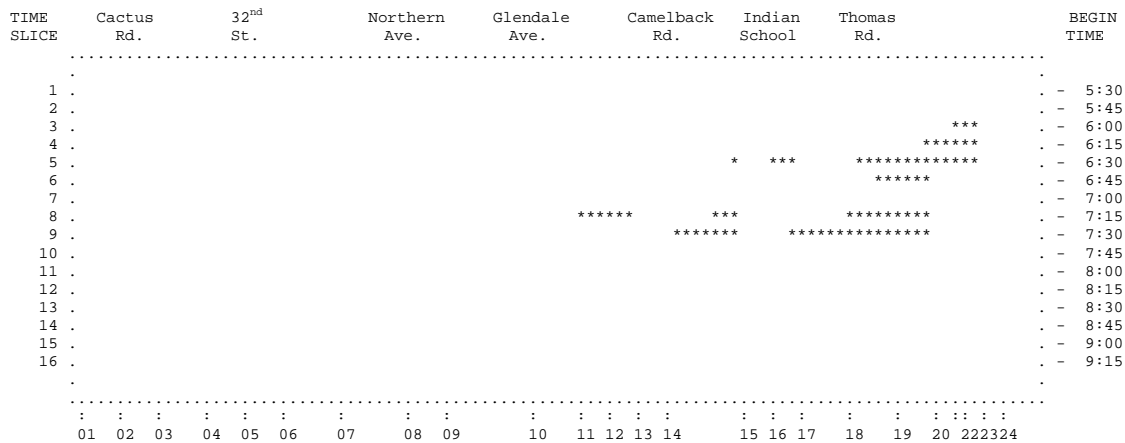
Queue Diagram of Alternative 2 for Segment D:



Alternative 3: Add a general purpose lane for the entire length of the segment. This alternative does not include adding an HOV lane or auxiliary lanes.

Result: Eliminates nearly all congestion except between I-10 and Indian School Road. Overall freeway travel time decreases by 14%.

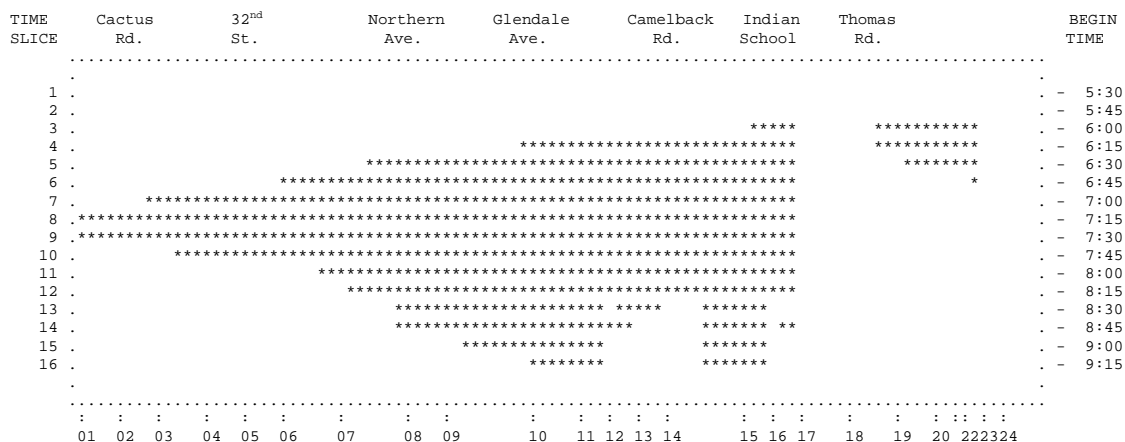
Queue Diagram of Alternative 3 for segment D:



Alternative 4: Add ramp metering at 900 vehicles per hour throughout the segment. This includes changing any existing HOV meter bypass lanes into dual meter ramps. Note that metering of several of these ramps is already in place.

Result: This alternative increases overall freeway travel time by approximately 4% due to increased ramp delay.

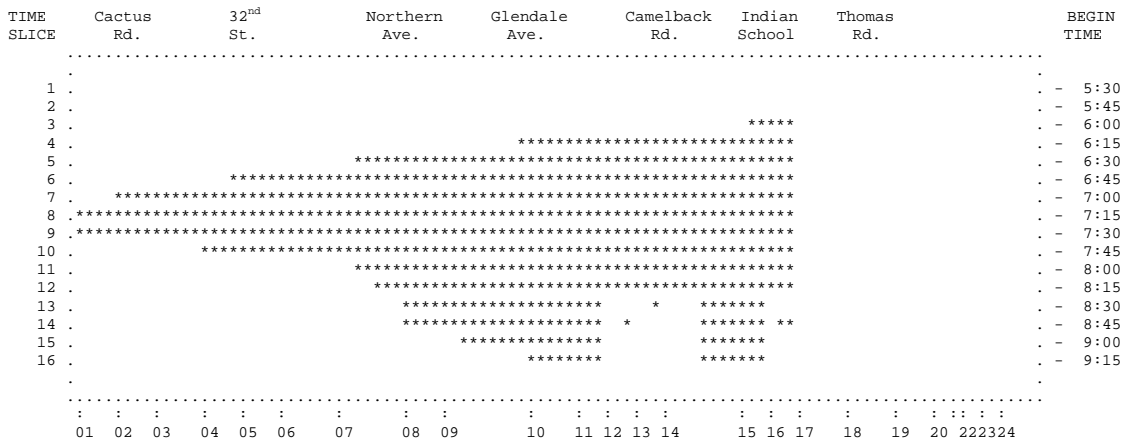
Queue Diagram of Alternative 4 for segment D:



Alternative 5: Add a general purpose lane from the on-ramp from southbound SR-51 to the Washington/Jefferson exit on southbound I-10. The intent of this alternative is to improve access to downtown Phoenix via Washington Street.

Result: This alternative resulted in essentially no impact on congestion on SR-51.

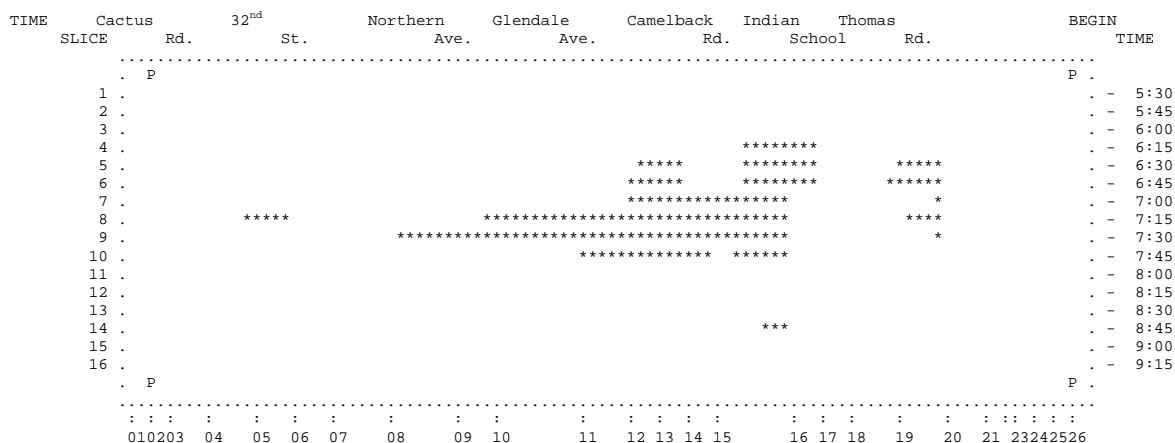
Queue Diagram of Alternative 5 for Segment D:



Alternative 6: Combine Alternative 1 and Alternative 2, adding auxiliary lanes between Glendale Road and Bethany Home Road and between Indian School Road and Thomas Road, and adding an HOV lane.

Result: This alternative significantly reduces congestion. Overall freeway travel time decreases 15%. Although congestion on SR-51 is reduced, it is important to note that this improvement will produce increased demand at the SR-51/SR-202 junction and the SR-51/SR-202/I-10 junction, resulting in a significant increase in congestion on I-10 through the downtown area.

Queue Diagram of Alternative 6 for segment D:



ANALYSIS SUMMARY – SEGMENT D

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	8708	26468	35176	36.2
Alternative 1	5810	26680	32490	56.2
Alternative 2	5631	24908	30539	43.1
Alternative 3	5308	27908	33215	63.0
Alternative 4	8744	27998	36743	35.8
Alternative 5	8691	26468	35159	36.2
Alternative 6	4363	25324	29686	56.0

Conclusions/Recommendations:

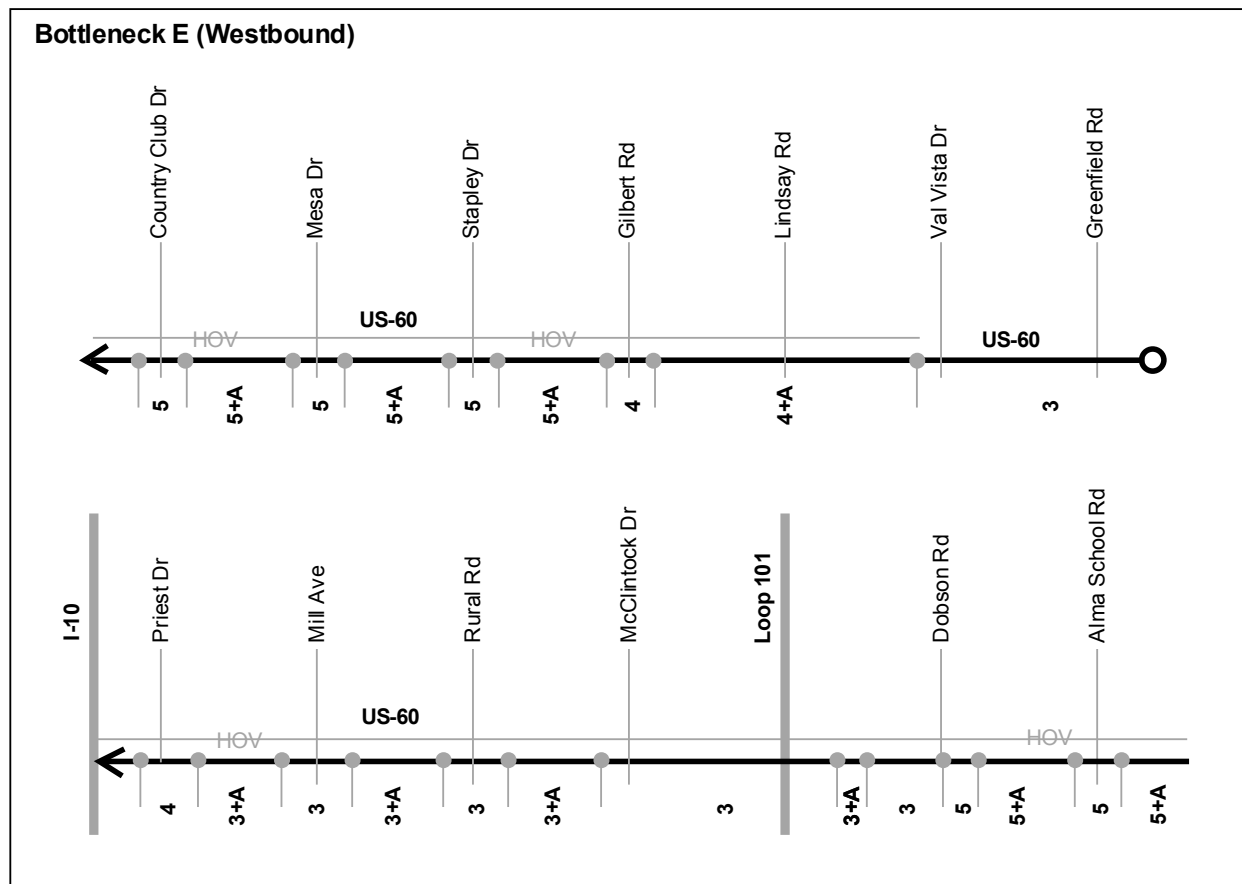
1. The addition of the currently planned HOV lane in combination with adding auxiliary lanes between Glendale Avenue and Bethany Home Road and between Indian School Road and Thomas Road will significantly reduce existing congestion on southbound SR-51 during the morning peak traffic period.
2. The addition of a lane on the southbound to westbound ramp connecting SR-51 with I-10 will produce greater demand and congestion on the downtown section of I-10. Therefore, this improvement is not recommended.

SEGMENT E **US-60 WESTBOUND: GREENFIELD ROAD TO I-10** **MORNING PEAK PERIOD**

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates the lane configuration along the E bottleneck segment. Lane numbers are shown below the black line. The letter “A” indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along the E bottleneck segment reaches a maximum of 176,000 vehicles (vpd) at the intersection of US-60 and Center Street (between Country Club Drive and Mesa Drive). The volume at this location during the AM peak hour is 11,400, which represents 6.5 percent of the total daily volume.

Westbound Traffic Volumes:

The volumes shown in the table below represent westbound counts along the E bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	AM Peak Hour Total Volume	AM Peak Hour GP Volume	AM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
I-10 / Greenfield Rd	4,500	-----	-----	6.5%	-----
I-17 / Gilbert Rd	5,000	-----	-----	6.3%	-----
I-17 / Mesa Dr	6,500	-----	-----	7.2%	1.5%
I-17 / Priest Dr	6,600	-----	-----	7.9%	0.9%

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	593	1.75	439	64	69	21
1999	594	1.72	427	59	74	34
2000	738	2.09	551	73	86	28
Total	1925	1.85	1417	196	229	83

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	593	436	157	0	29
1999	594	396	197	1	28
2000	738	526	210	2	24
Total	1925	1358	564	3	81

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

Observations: During the peak period, westbound congestion was found on US-60 between Greenfield Road and Country Club Drive. Ongoing construction between Val Vista Drive and Dobson Road may have exacerbated the congestion (right shoulder closed). Average speeds along this segment typically ranged from approximately 20 to 30 mph. Traffic flow consistently improved west of Country Club Drive, where the road widened from 3 to 4 lanes.

During most observations, westbound congestion was found on US-60 between Loop 101 and Mill Avenue; average estimated speeds along this segment typically ranged from approximately 15 to 25 mph. Ongoing construction between McClintock Drive and Mill Avenue may have exacerbated the congestion (right shoulder closed).

During the Peak period, westbound congestion was found on US-60 approaching I-10; average estimated speeds ranged widely, from approximately 25 to 45 mph. The merge into congested flow on I-10 appeared to cause or exacerbate the congestion.

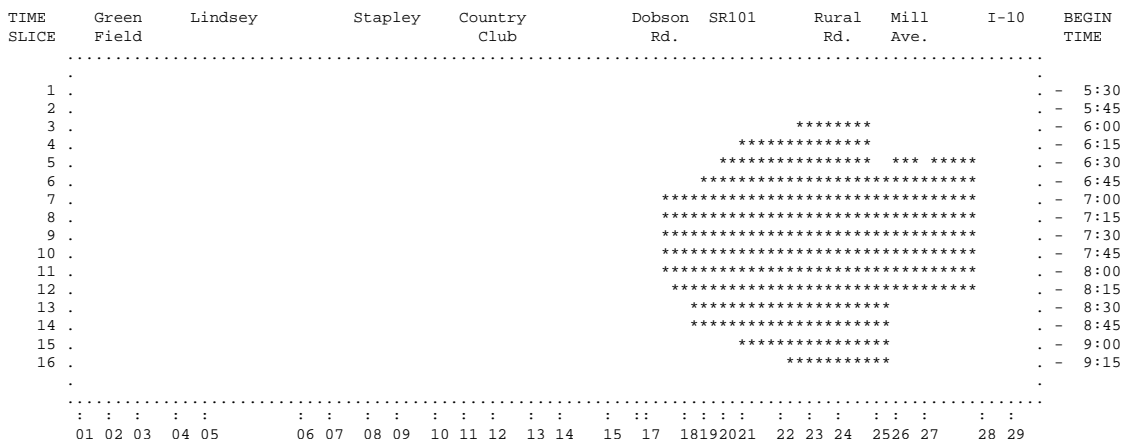
Density Data: Level of Service F (density greater than 45 vehicles per lane-mile) between I-10 and Priest Drive between 6:30 and 8:30 am; between Mill Avenue and McClintock Drive between 6:00 an 8:30 am; between Country Club Drive and Val Vista Drive between 6:00 and 9:00 am; and between Val Vista Drive and Greenfield Road between 6:00 and 7:30 am.

FREQ ANALYSIS

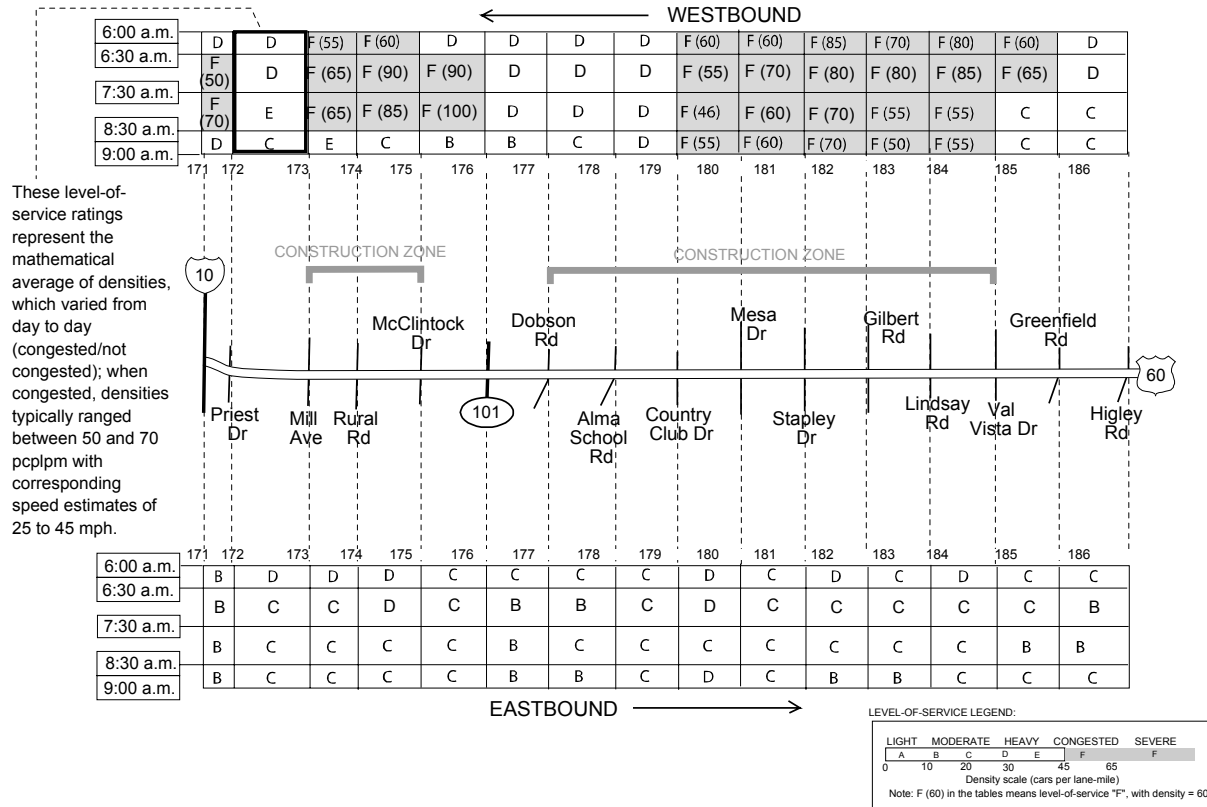
Segment E: *US-60 WB; Greenfield Road to I-10; 5:30 to 9:30 am*

Existing Conditions: Bottlenecks currently occur at Loop 101, between Rural Road and Mill Avenue and at Priest Road. Since traffic data for this freeway segment was collected during construction, it was not possible to develop an accurate model of existing conditions. The existing conditions model developed for this segment includes the new freeway geometry and lane configuration that is under construction. This includes a cross-section of 3+1 within the City of Tempe and 5+1+A from the Loop 101 interchange to Power Road.

Queue Diagram of Existing Conditions for Segment E
(Results reflect possible conditions after the completion of construction):



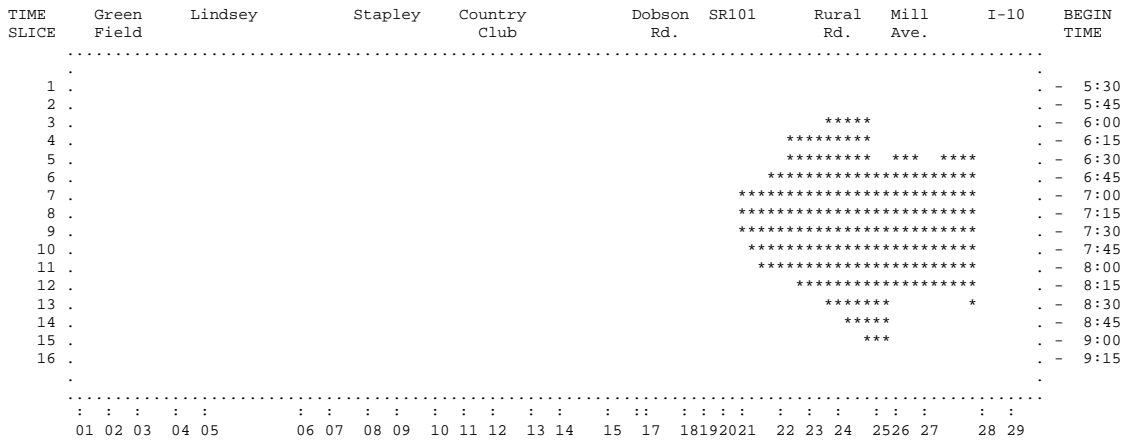
**US Route 60
(Between I-10 & Higley Rd)
Morning - Fall 2001**



Alternative 1: Add ramp metering at 900 vehicles per hour throughout the segment.

Result: Congestion on the freeway segment within the City of Tempe is reduced; however, lengthy queues at on-ramps will occur. Overall freeway travel time increases 29%.

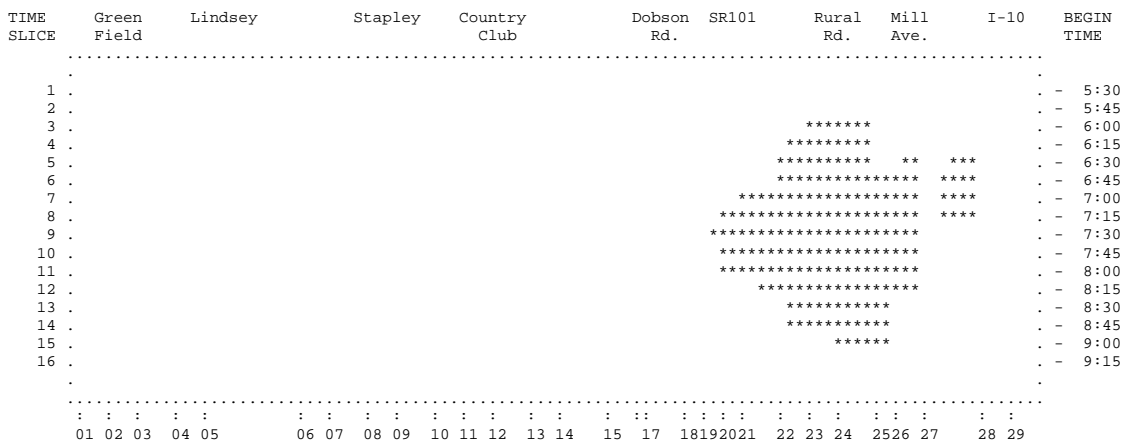
Queue Diagram of Alternative 1 for Segment E:



Alternative 2: Include the HOV left exit-ramp to the I-10 HOV lane. For modeling purposes it was assumed that 10% of the traffic contains 2 or 3+ passengers and thus can use the HOV ramp. This ramp is already in operation.

Result: This alternative reduces delays somewhat. Overall freeway travel time decreases 5%.

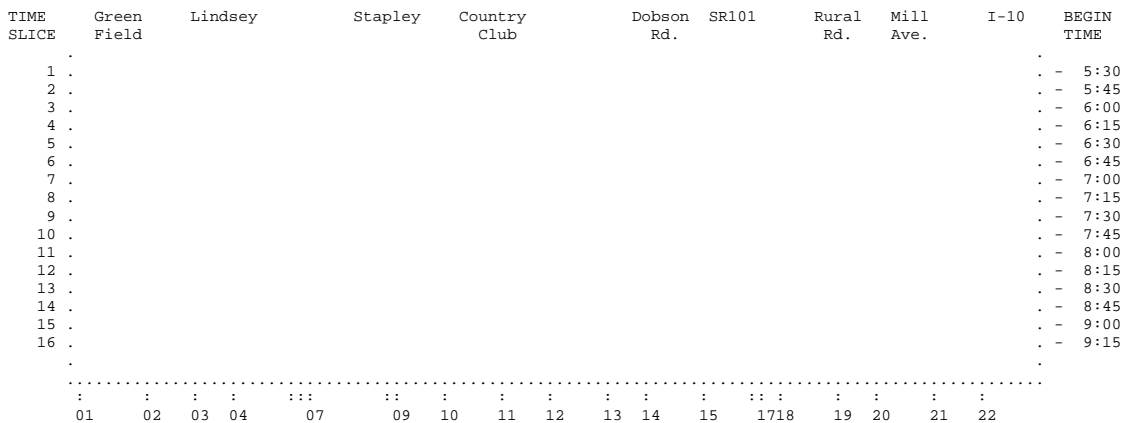
Queue Diagram of Alternative 2 for Segment E:



Alternative 3: The intersection improvements needed to eliminate the existing bottlenecks were evaluated. Providing four general-purpose lanes from Loop 101 to Mill Avenue, five lanes from Mill Avenue to I-10, and two lanes on the WB to SB freeway-to-freeway connector ramp will eliminate peak period congestion that occurs between Loop 101 and I-10.

Result: Eliminating the existing bottlenecks between Loop 101 and I-10 could significantly reduce overall freeway travel time on this section of US-60. The actual travel time savings will depend upon the latent demand that returns to US-60 once on-going construction is completed. Conditions downstream on I-10 will be impacted by the higher traffic volumes entering from the US-60 westbound on-ramp. The potential impacts of this increased demand at the westbound I-10/US-60 ramp junction were evaluated and are presented in the discussion addressing potential improvements to I-10 from Ray Road to 40th Street (Segment B).

Queue Diagram of Alternative 3 for Segment E:



Analysis Summary – Segment E

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	8899	4504	13403	40.9
Alternative 1	6813	10583	17396	51.1
Alternative 2	7553	5259	12812	47.1
Alternative 3	5275	5259	10534	67.5

Conclusions/Recommendations:

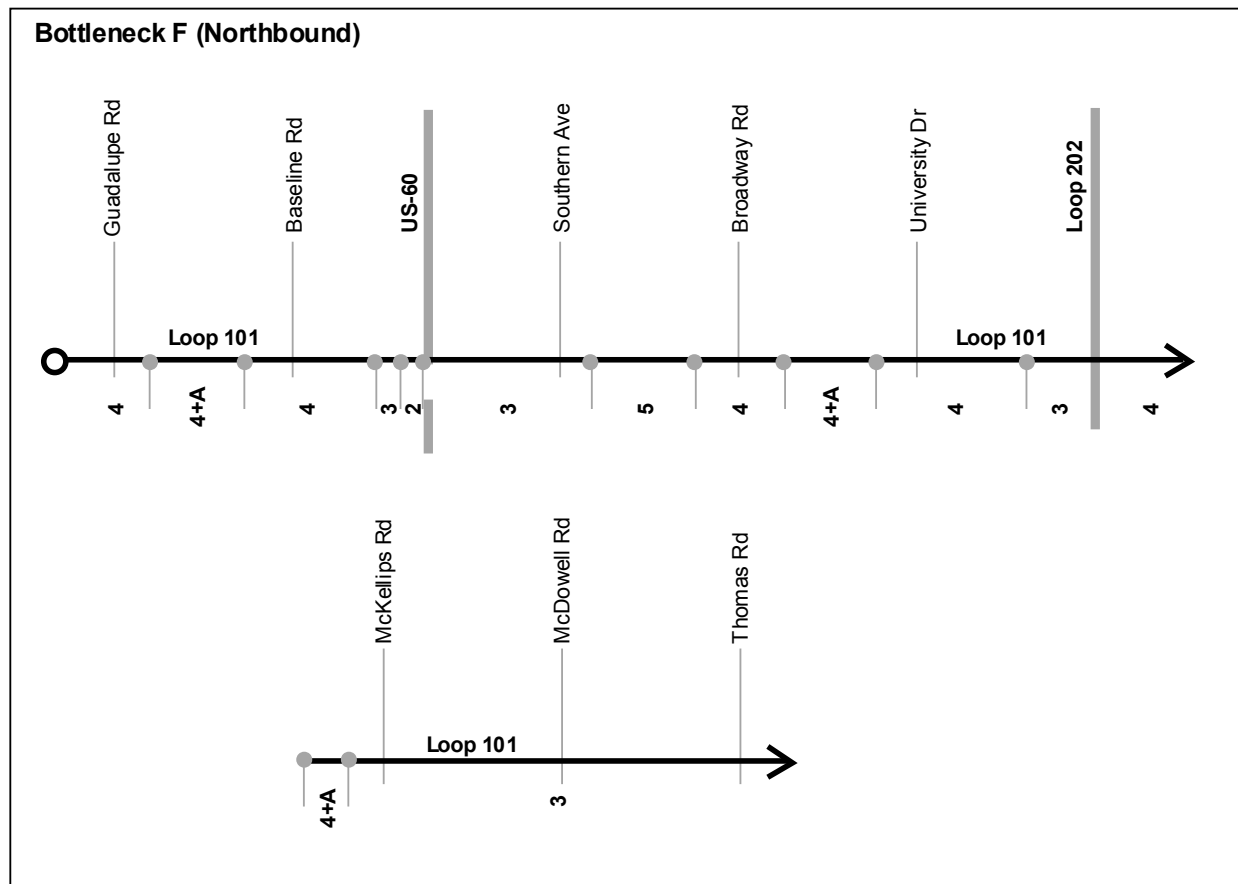
Although an accurate model of existing conditions on this freeway section could not be developed, the evaluation of conditions with the on-going construction project complete indicates that the reduced freeway capacity (3+1+A) west of Loop 101 will create congestion. Construction of a collector-distributor road on I-10 will increase the capacity of the I-10/US-60 junction, potentially reducing the level of congestion on westbound US-60 during the morning peak period. Eliminating the bottleneck west of Loop 101 will result in higher traffic volumes entering I-10 from the westbound US-60 on-ramp, thereby impacting I-10 traffic flow.

SEGMENT F
LOOP 101 NORTHBOUND: GUADALUPE ROAD TO THOMAS ROAD
MORNING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates the lane configuration along the F bottleneck segment. Lane numbers are shown below the black line. The letter “A” indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along the F bottleneck segment reaches a maximum of 192,000 vehicles (vpd) north of the intersection of Loop 101 and Southern Ave. The volume at this location during the AM peak hour is 14,200, which represents 7.4 percent of the total daily volume.

Northbound Traffic Volumes:

The volumes shown in the table below represent northbound counts along the F bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

Location	AM Peak Hour Total Volume	AM Peak Hour GP Volume	AM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
Loop 101 / Southern Av	8,500	-----	-----	8.7%	-----
Loop 101 / University Dr	9,100	-----	-----	9.4%	-----
Loop 101 / McKellips Rd	6,600	-----	-----	8.1%	1.2%
Loop 101 / McDowell Rd	6,500	-----	-----	8.4%	-----
Loop 101 / Thomas Rd	7,000	-----	-----	8.2%	0.5%

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	97	0.68	63	16	14	4
1999	72	0.40	43	7	14	8
2000	143	0.64	94	12	28	9
Total	312	0.58	200	35	56	21

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	97	71	26	0	2
1999	72	57	14	1	7
2000	143	105	37	1	0
Total	312	233	77	2	9

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

Observations: During the peak period, an extended zone of northbound congestion was found on Loop 101 between Guadalupe Road and Loop 202; average estimated speeds through this segment typically ranged from 30 to 50 mph. Factors contributing to the congestion were 1) the lane drop [3 lanes to 2] at US-60, and 2) vehicles weaving into the right two lanes to exit at Loop 202.

During most observations, northbound congestion was found on Loop 101 between Loop 202 and Thomas Road; average estimated speeds through this segment typically ranged from 30 to 50 mph. The primary bottleneck was the lane drop [4 lanes to 3] at McKellips Road; north of McKellips Road, vehicle speeds typically improved.

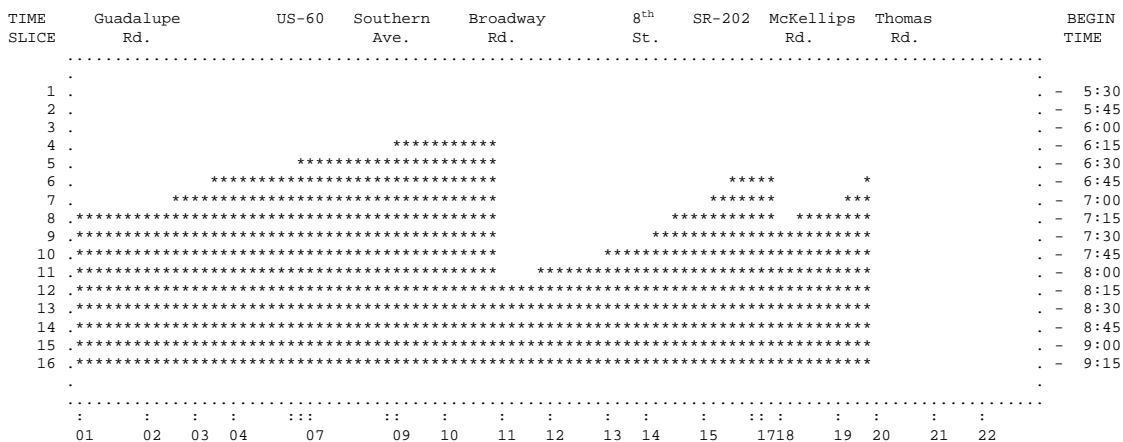
Density Data: Level of Service F (density greater than 45 vehicles per lane-mile) southbound between Thomas Road and McDowell Road between 7:30 and 8:30 am; northbound between Thomas Road and McDowell Road between 6:30 and 9:00 am; between McDowell Road and the Loop 202 exits between 7:30 and 8:30 am; between University Drive and Apache Boulevard between 6:30 and 7:30 am; between Apache Boulevard and Southern Avenue between 6:30 and 8:30 am; and between the US-60 interchange and Baseline Road between 6:30 and 7:30 am.

FREQ ANALYSIS

Segment F: Loop 101 NB; Guadalupe Road to Thomas Road; 5:30 to 9:30 AM

Existing Conditions: Existing bottlenecks occur at Thomas Road, McKellips Road and Broadway Road. The resulting congestion extends from Thomas Road to south of Guadalupe Road. The two freeway interchanges spaced 3.5 miles apart and six on-ramps within these 3.5 miles create significant merging and weaving activity that contributes to the reduced freeway capacity and congestion.

Queue Diagram of existing conditions for Segment F:



Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

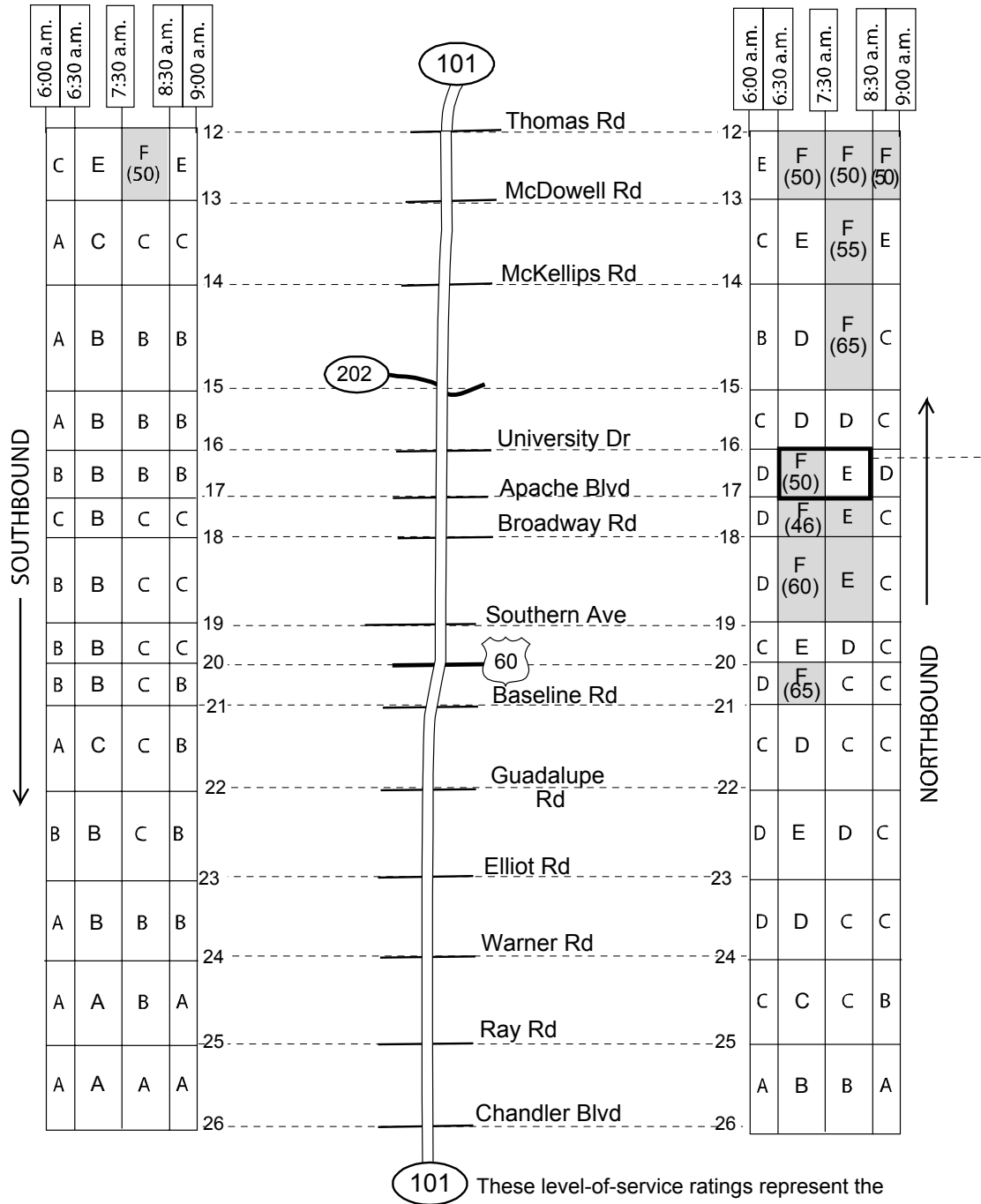
ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

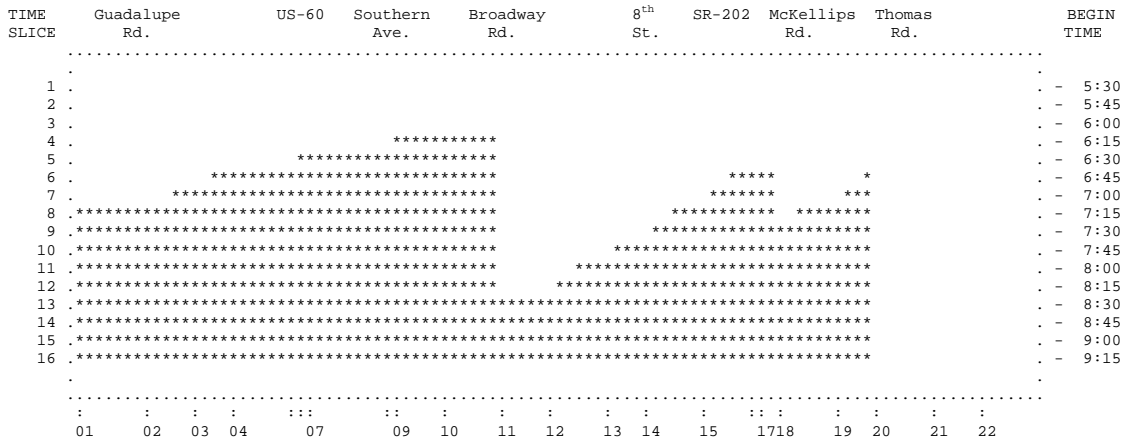
Loop 101-Pima Freeway (Between Thomas Rd & Chandler Blvd) Morning - Fall 2001



Alternative 1: Add a general-purpose lane through the Loop 101/Loop 202 interchange.

Result: This alternative does nothing to relieve congestion. Overall, freeway travel time increases slightly.

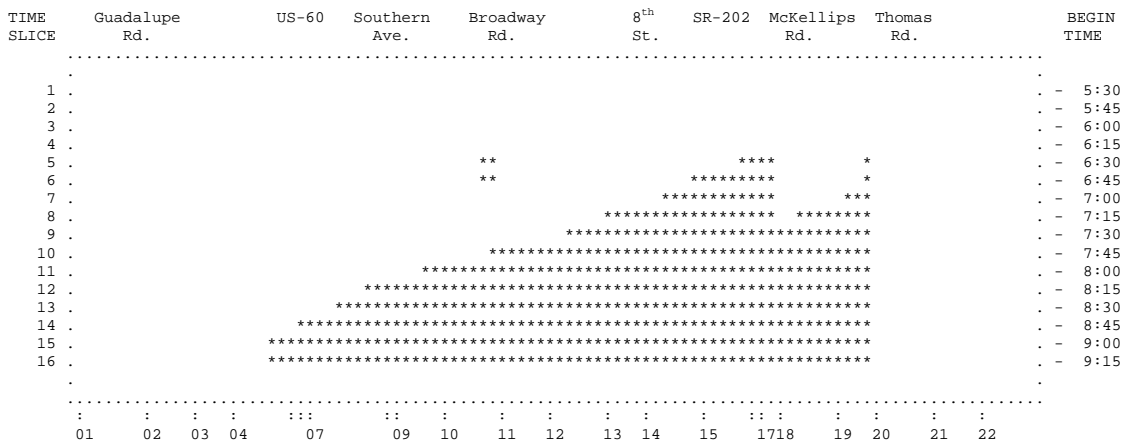
Queue Diagram of Alternative 1 for Segment F:



Alternative 2: Add a general purpose lane from the US-60 interchange through the Loop 202 interchange.

Result: This alternative significantly reduced congestion at the Broadway Road bottleneck, however, the bottlenecks at McKellips Road and Thomas Road continue to create congestion. Overall, freeway travel time increases slightly.

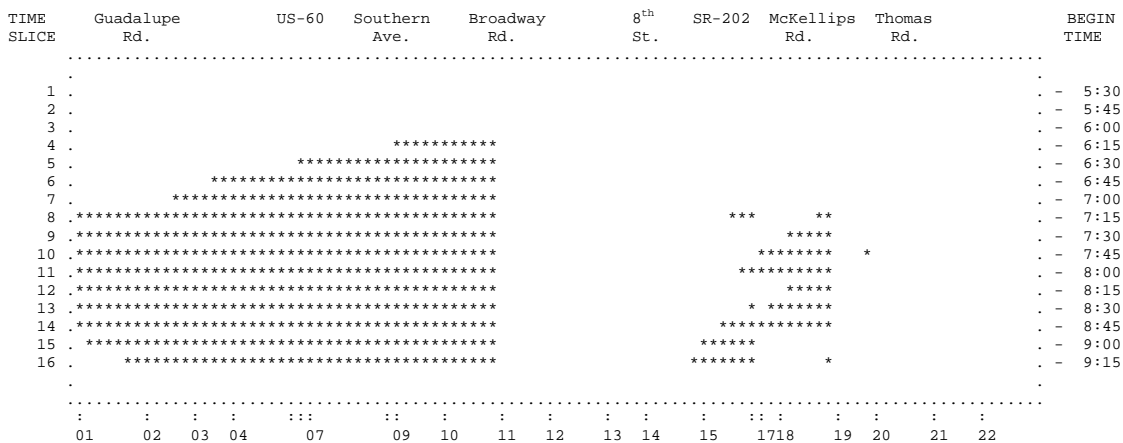
Queue Diagram of Alternative 2 for Segment F:



Alternative 3: Add auxiliary lanes from the McKellips Road to Thomas Road. This alternative does not include the addition of a general purpose lane.

Result: This alternative reduces congestion at the Thomas Road and McKellips Road bottlenecks, however does not impact the Broadway Road bottleneck. Overall, freeway travel time decreases 10%.

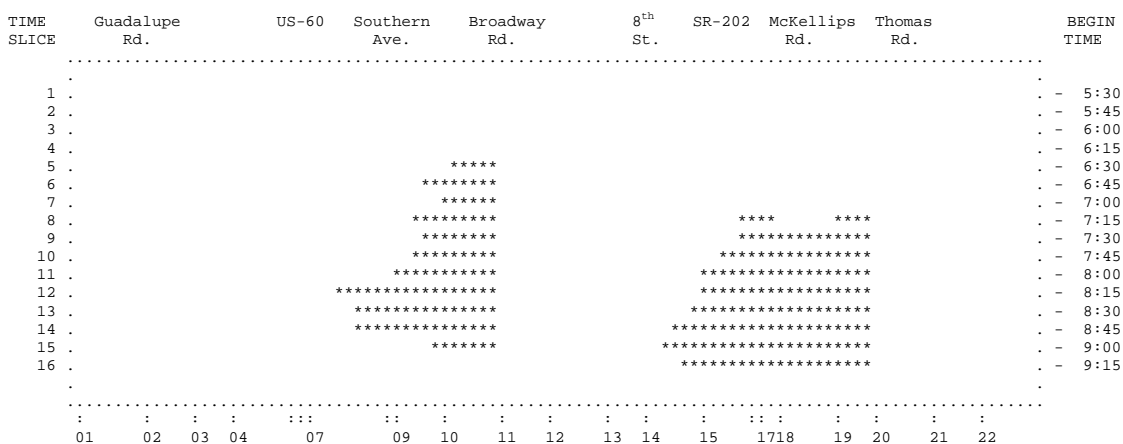
Queue Diagram of Alternative 3 for Segment F:



Alternative 4: Add ramp metering at 900 vehicles per hour and 1600 for dual meters throughout the segment.

Result: This alternative reduces congestion at each bottleneck, although long queues will occur at several on-ramps. Overall, freeway travel time decreases 5%.

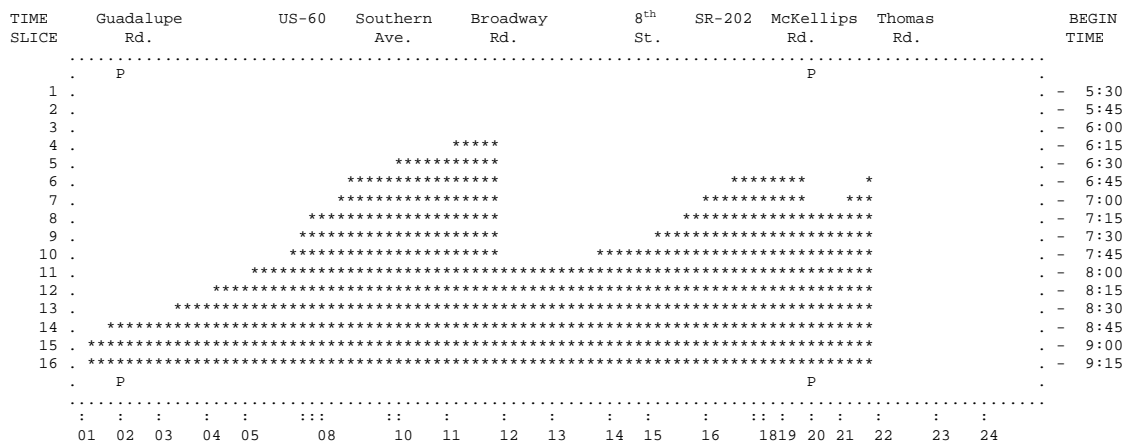
Queue Diagram of Alternative 4 for Segment F:



Alternative 5: Add an HOV lane to this segment. For modeling purposes, it was assumed that 10% of the traffic contains 2 or 3+ passengers and thus can use the HOV lane. This does not include the addition of any other physical improvements.

Result: This alternative decreases the duration of the congestion. Overall, freeway travel time decreases 15%.

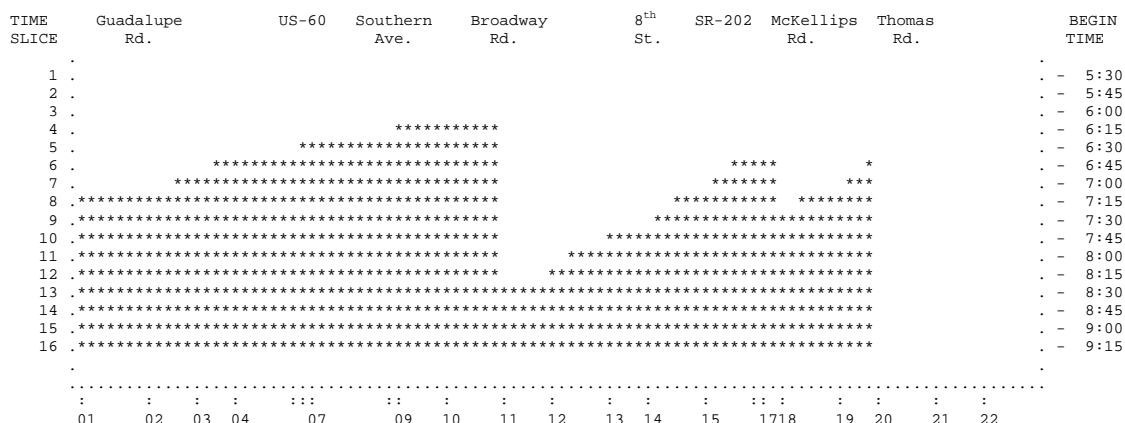
Queue Diagram of Alternative 5 for Segment F:



Alternative 6: Extend the auxiliary lane from the Broadway Road on-ramp to the Loop 202 off-ramp. The two outside lanes are exit only to Loop 202. The intent of this improvement is to provide added capacity for the heavy north to west movement at the Loop 101/Loop 202 interchange. Currently, peak hour demand at the northbound Loop 202 off-ramp exceeds 5600 vph. The two-lane exit ramp provides a capacity of between 3000 and 3600 vph.

Result: This alternative does not provide any benefit to traffic flow on northbound Loop 101 or to the Loop 101 to Loop 202 connector ramp. However, it will provide additional storage for queuing on the connector ramp. Additional ramp capacity is needed in order to alleviate the congestion on the connector ramp.

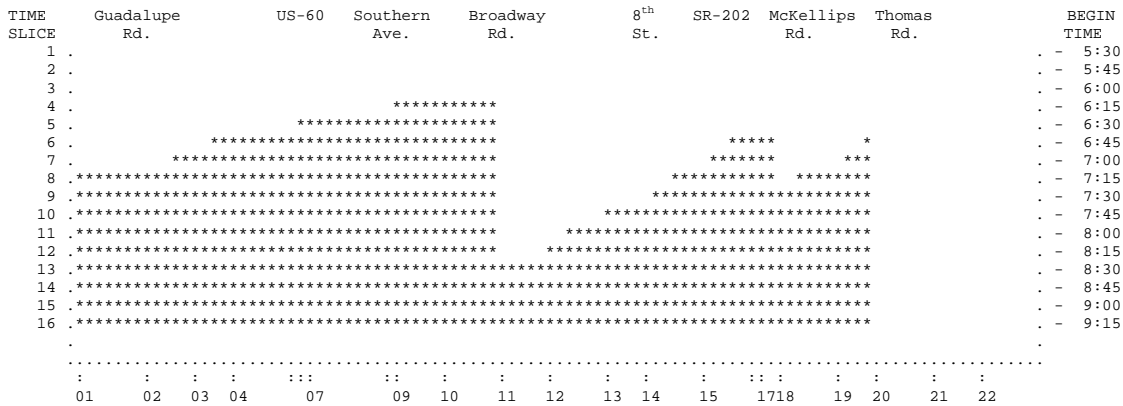
Queue Diagram of Alternative 6 for Segment F:



Alternative 6A: Add a third lane to the northbound Loop 202 off-ramp.

Result: This added ramp capacity significantly reduces ramp delay, particularly on the Loop 101 to Loop 202 connector ramp; it does not however, reduce congestion on northbound Loop 101. The impacts of this alternative on traffic flow on Loop 202 are addressed in the discussion for Segment G.

Queue Diagram of Alternative 6A for Segment F:



ANALYSIS SUMMARY – SEGMENT F

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	13937	20356	34293	16.9
Alternative 1	14067	20256	34323	16.9
Alternative 2	10607	24384	34991	24.0
Alternative 3	10652	20239	30891	23.6
Alternative 4	5855	35858	41712	41.3
Alternative 5	9762	19443	29205	19.8
Alternative 6	14093	20349	34442	16.7
Alternative 6A	14093	5756	19850	16.7

Conclusions/Recommendations:

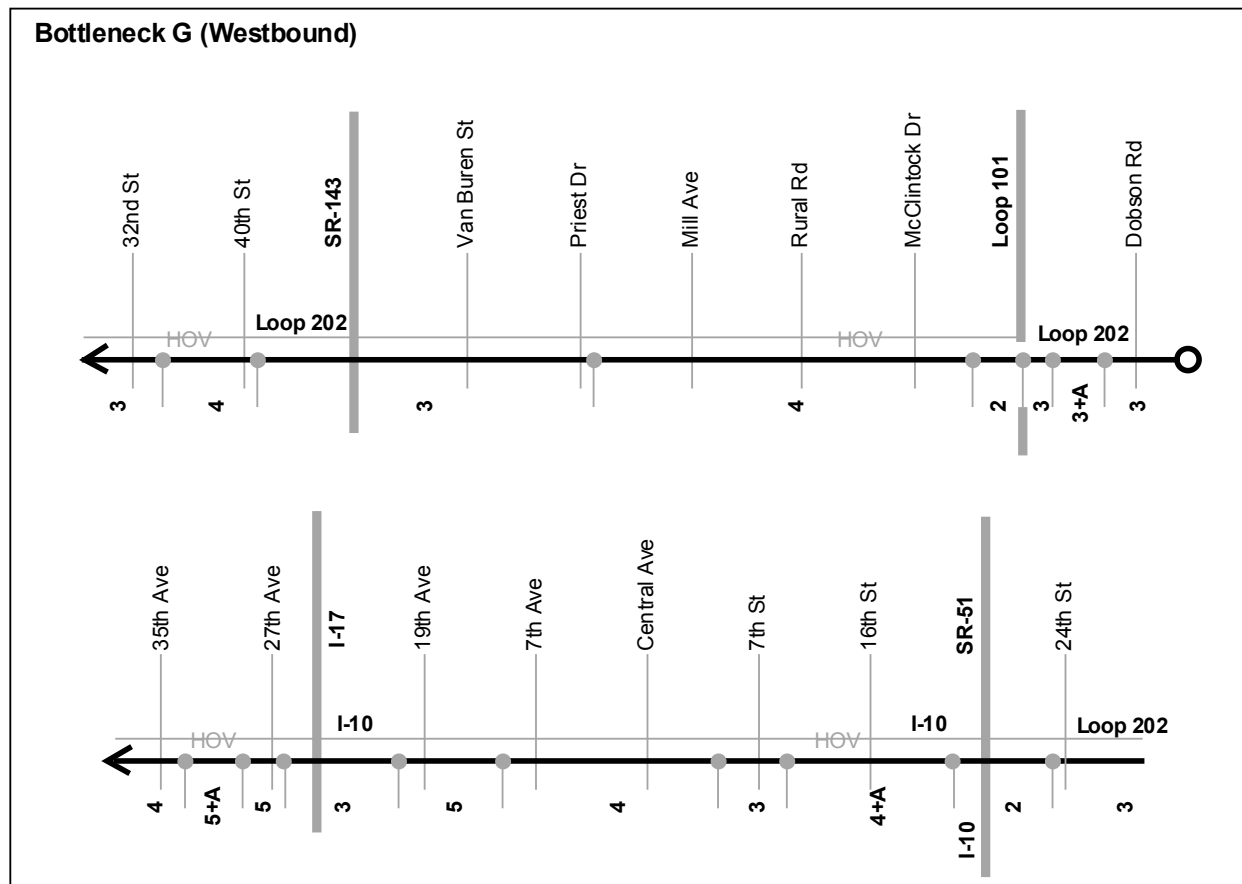
1. The construction of auxiliary lanes from McKellips Road to Thomas Road, in combination with the installation of ramp metering, will reduce existing congestion on this section of Loop 101 to some degree. Adding a fourth general purpose lane north of McKellips Road will reduce congestion further, however, the bottleneck at Broadway Road will remain.
2. Installation of ramp metering will benefit traffic flow, particularly between the US-60 and Loop 202 interchanges.
3. Heavy demand at the northbound Loop 101 to Loop 202 connector ramp exceeds ramp capacity by approximately 50%. This demand may decrease upon completion of the widening on US-60. Adding ramp capacity will increase the volume of traffic entering westbound Loop 202 from Loop 101, thereby producing added congestion on Loop 202.

SEGMENT G
LOOP 202 WESTBOUND: DOBSON ROAD TO 35TH AVENUE (ON I-10)
MORNING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates the lane configuration along the G bottleneck segment. Lane numbers are shown below the black line. The letter “A” indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along the G bottleneck segment reaches a maximum of 259,000 vehicles (vpd) at the intersection of I-10 and 7th St. The volume at this location during the AM peak hour is 17,900, which represents 6.9 percent of the total daily volume.

Westbound Traffic Volumes:

The volumes shown in the table below represent westbound counts along the G bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	AM Peak Hour Total Volume	AM Peak Hour GP Volume	AM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
Loop 202 / Dobson Rd	5,400	-----	-----	13.1	-----
Loop 202 / Mill Av	9,800	8,700	1,100	9.2%	1.0%
Loop 202 / 32 nd St	8,300	7,400	900	7.5%	0.8%
I-10 / 16 th St	9,900	8,700	1,200	7.2%	1.5%
I-10 / 7 th Av	8,800	8,400	400	7.9%	-----
I-10 / 31 st Av	5,900	5,500	400	5.3%	6.6%

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	1369	2.30	1036	145	149	39
1999	1229	1.97	903	135	142	49
2000	1292	1.98	937	178	145	32
Total	3890	20.8	2876	458	436	102

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	1369	1019	347	3	28
1999	1229	893	333	3	43
2000	1292	913	376	3	41
Total	3890	2825	1056	9	122

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on pages G-4 and G-5.

Observations: During most observations, westbound congestion was typically found on Loop 202 between Loop 101 (Pima Freeway) and Mill Avenue; average estimated speeds typically ranged from approximately 30 to 50 mph. This congestion appeared to be caused or exacerbated by weaving and merging associated with the interchanges along this corridor. At its maximum observed extent, the queue extended back onto Loop 101.

During most observations, westbound congestion was typically found on Loop 202 between SR-143 and I-10/SR-51; average estimated speeds typically ranged from approximately 30 to 50 mph. Factors contributing to the congestion were 1) the lane drop [4 lanes to 3] at 32nd Street, and 2) the lane drop [3 lanes to 2] at I-10/SR-51.

During the peak period, westbound congestion was typically found in the freeway ramp from Loop 202 to I-10; this congestion appeared to be caused or exacerbated by weaving west of the SR-51/Loop 202/I-10 Interchange.

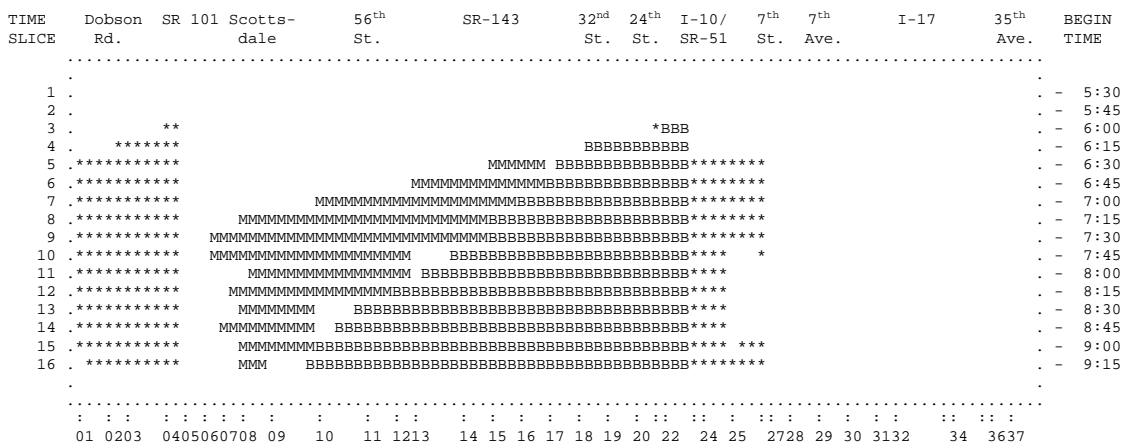
Density Data: LOS F (density greater than 45 vehicles per lane-mile) between 24th Street and 40th Street between 7:30 and 9:00 am; between Mill Avenue and McClintock Drive between 6:30 and 8:30 am; and between McClintock Drive and the Loop 101 Interchange between 7:30 and 8:30 am.

FREQ ANALYSIS

Segment G: Loop 202 WB; Dobson Road to 35th Avenue (on I-10); 5:30 to 9:30 am

Existing Conditions: Bottlenecks currently occur at the Loop 202/SR-51/I-10 interchange and at the Loop 101/Loop 202 interchange. Several physical and operational bottlenecks exist. Physical bottlenecks exist at 7th Street and the Loop 101 interchange. At the Loop 202/SR-51/I-10 interchange, heavy merging and weaving between Loop 202/SR-51 traffic and I-10 traffic significantly reduces the capacity of this freeway segment.

Queue Diagram of Existing Conditions for Segment G:



Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

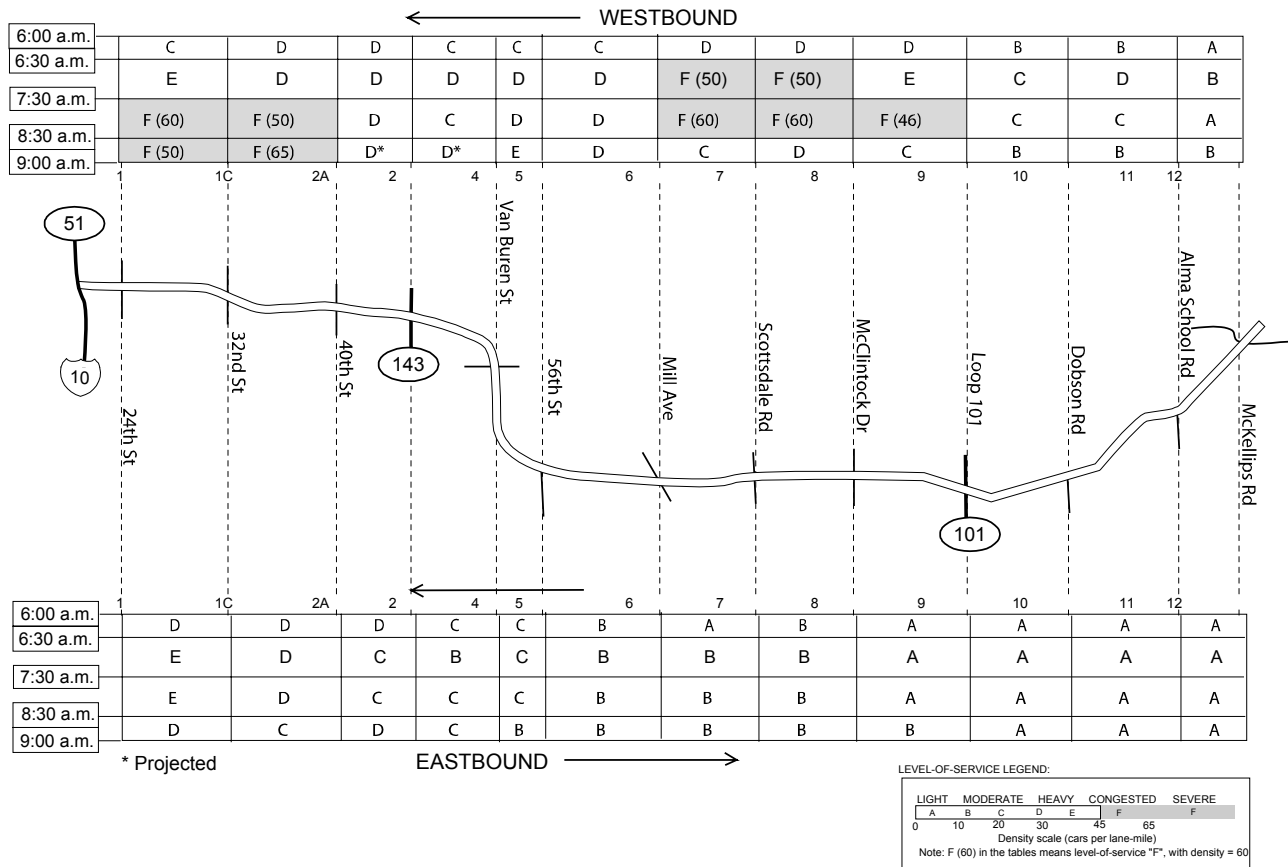
ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

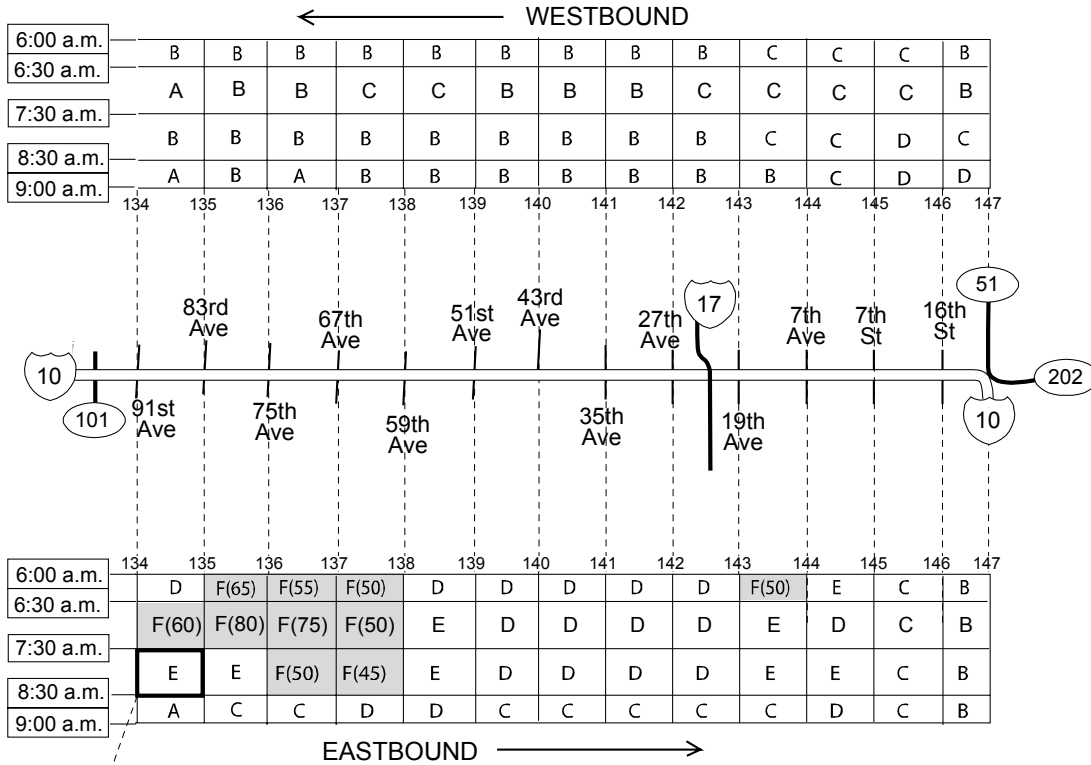
B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

Loop 202 **Morning - Fall 2001**

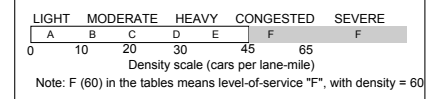


I-10
(Between 91st Ave & Loop 202 / SR 51)
Morning - Fall 2001



These level-of-service ratings represent the mathematical average of densities, which varied during this hour (congested/not congested); when congested, densities ranged widely, between 90 and 45 pcplpm with corresponding speed estimates of 20 to 50 mph.

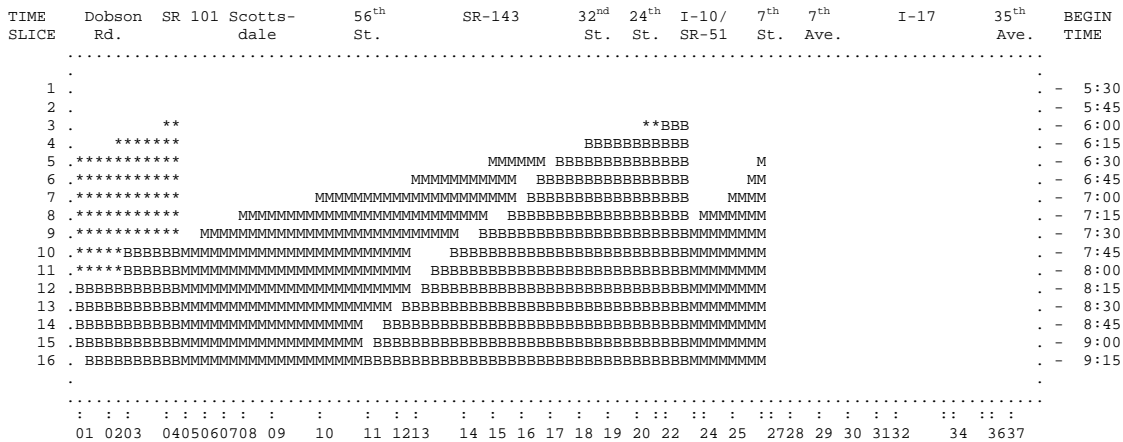
LEVEL-OF-SERVICE LEGEND:



Alternative 1: Change the I-10 HOV lane from the Loop 202 interchange to the I-17 interchange into a general purpose lane and allow all traffic to exit at the 3rd Street left off-ramp.

Result: The model results suggest that this alternative may actually worsen the current situation, as vehicles from Loop 202/SR-51 weave across the four I-10 lanes to reach the left side exit at 3rd Street. This alternative will likely reduce weaving and merging at the Loop 202/SR-51/I-10 junction as a portion of I-10 traffic that normally exits at 7th Street uses the 3rd Street exit instead.

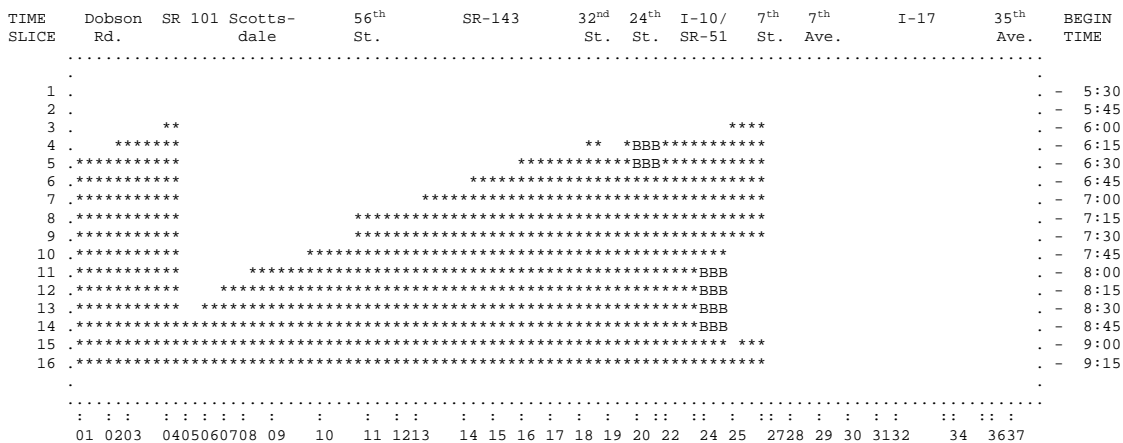
Queue Diagram of Alternative 1 for Segment G:



Alternative 2: Add additional lanes on the southbound to westbound freeway-to-freeway ramps at both the Loop 202/SR-51/I-10 and Loop 202/Loop 101 interchanges.

Result: This alternative significantly reduces delays caused by merging, however, the increased demand entering the freeway exceeds available capacity and produces similar congestion. Overall, freeway travel time decreases slightly.

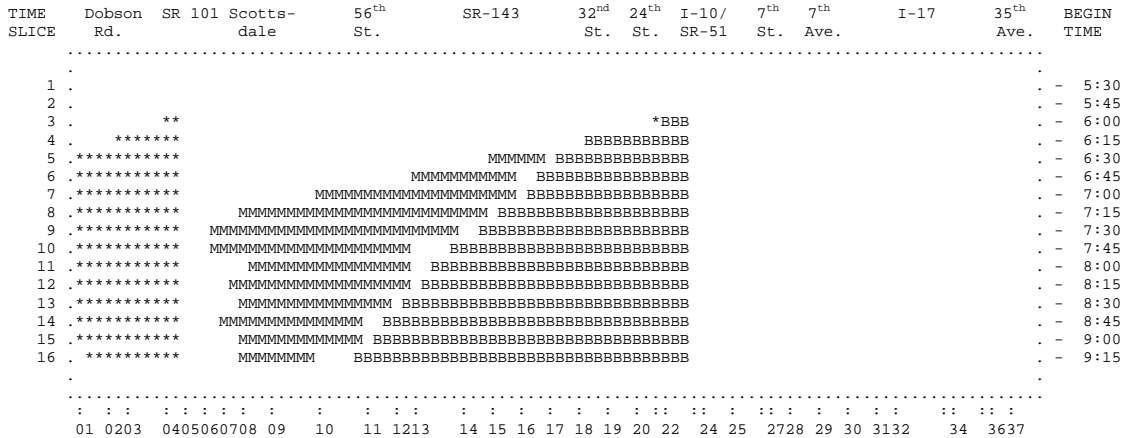
Queue Diagram of Alternative 2 for Segment G:



Alternative 3: Add ramp metering at 900 vehicles per hour throughout the segment.

Result: This alternative has no effect on mainline or ramp congestion. Improved freeway operation could be achieved by tightening down on the ramp metering rates, however this improvement would be offset by increased ramp delays.

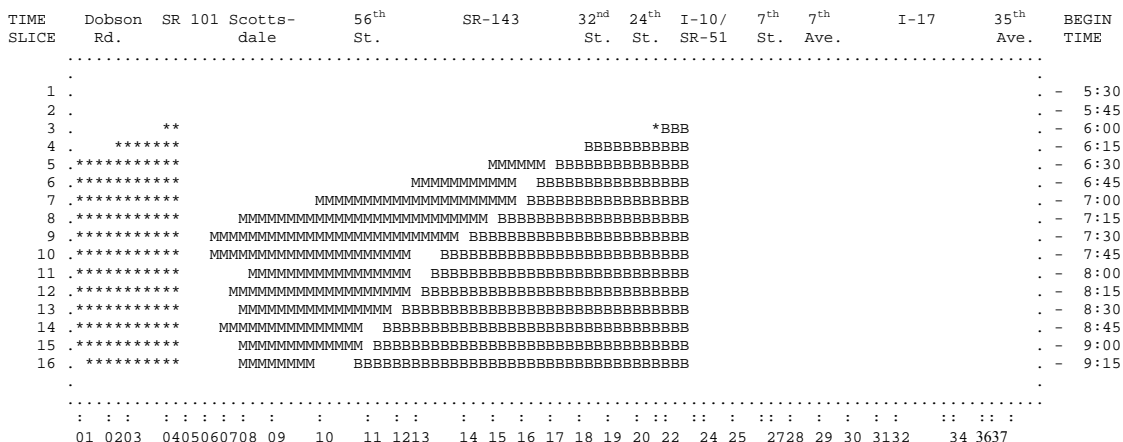
Queue Diagram of Alternative 3 for Segment G:



Alternative 4: Add a general purpose lane from the Loop 202/SR-51/I-10 interchange through the tunnel to the 19th Avenue off-ramp.

Result: This alternative eliminates congestion caused by the 7th Street bottleneck, however, does not improve conditions in the merge/weave area. Overall, travel times remain unchanged.

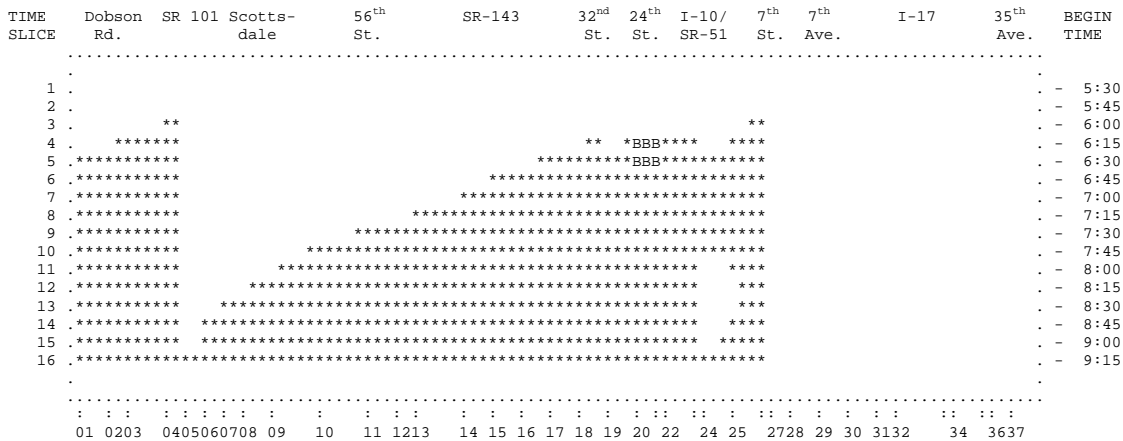
Queue Diagram of Alternative 4 for Segment G:



Alternative 5: Add an outside lane between the Loop 202/SR-51 on-ramp and the 7th Street off-ramp. The two outside lanes would be exit only to 7th Street.

Result: This alternative reduces the merging problem, however, it does not add needed capacity to the mainline. Overall, freeway travel time increases 13%.

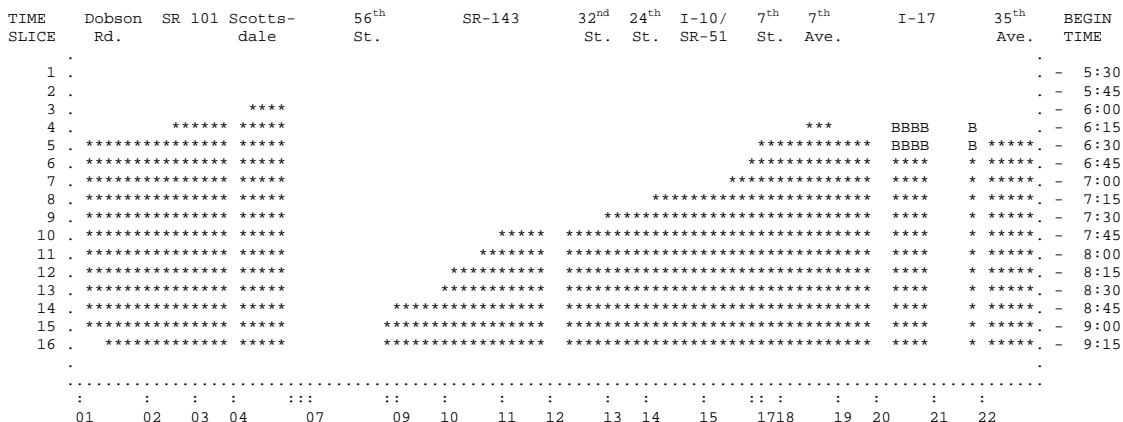
Queue Diagram of Alternative 5 for Segment G:



Alternative 5A: Add an outside lane between the Loop 202/SR-51 on-ramp and the 7th Street off-ramp. The two outside lanes would be exit only to 7th Street. Close the 16th Street on-ramp. The 16th Street on-ramp demand is shifted to the 7th Street on-ramp.

Result: This alternative is slightly better than Alternative 5, in which the 16th Street on-ramp remains open - however overall, freeway travel time remains unchanged when compared with existing conditions. Currently, the 16th Street on-ramp demand is relatively low, probably due to the congested conditions on I-10. As such, eliminating the ramp will not have a significant effect on freeway conditions. Actually, additional ramp delay at the 7th Street on-ramp will likely occur.

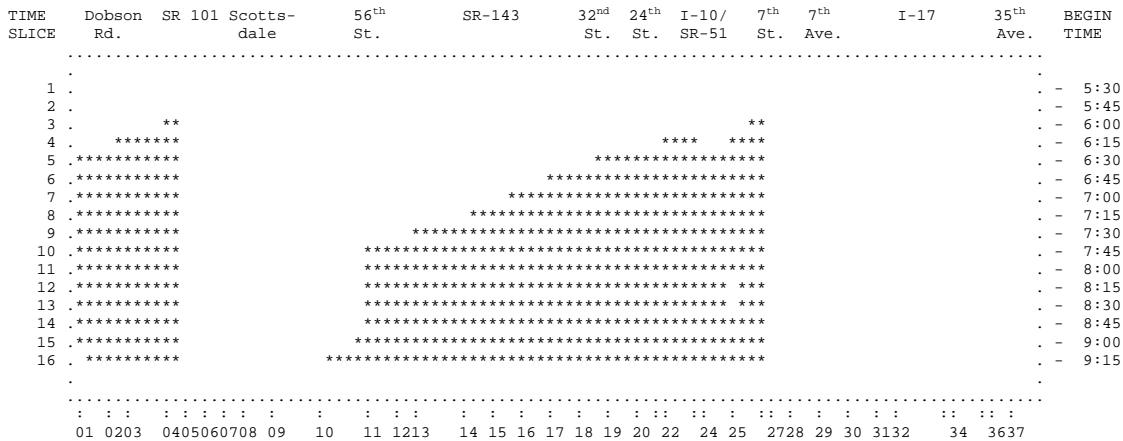
Queue Diagram of Alternative 5A for Segment G:



Alternative 6: Add auxiliary lanes at 32nd Street and 24th Street in addition to the two-lane mandatory off-ramps at 7th Street.

Result: The auxiliary lanes reduce freeway congestion somewhat. Overall, freeway travel time decreases 5%.

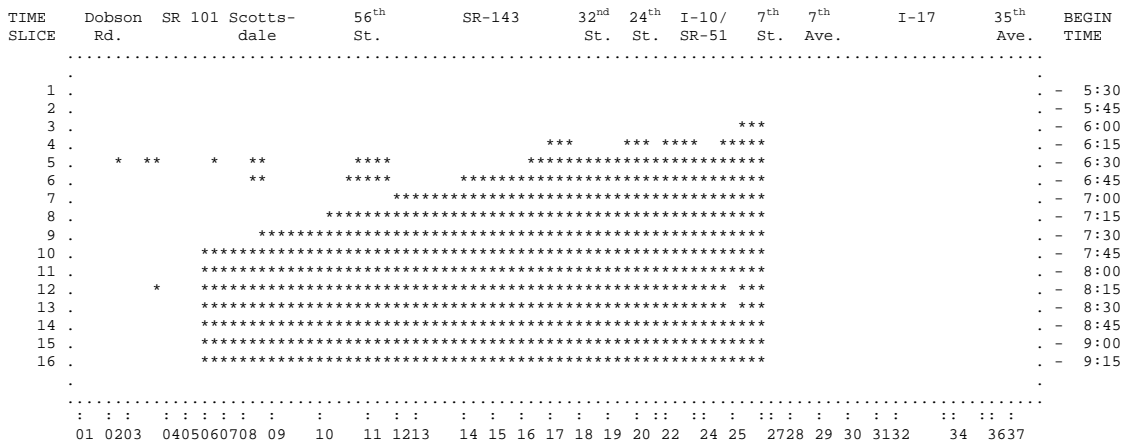
Queue Diagram of Alternative 6 for Segment G:



Alternative 7: Add a third general purpose lane to Loop 202 at the Loop 101/Loop 202 interchange. This is in addition to the auxiliary lanes at 32nd Street and 24th Streets and the two-lane mandatory off-ramps at 7th Street.

Result: This alternative eliminates the congestion at the Loop 101/Loop 202 interchange, however, sends the excess demand downstream where it runs into queuing caused by the 7th Street bottleneck. Overall, freeway travel time decreases 5%.

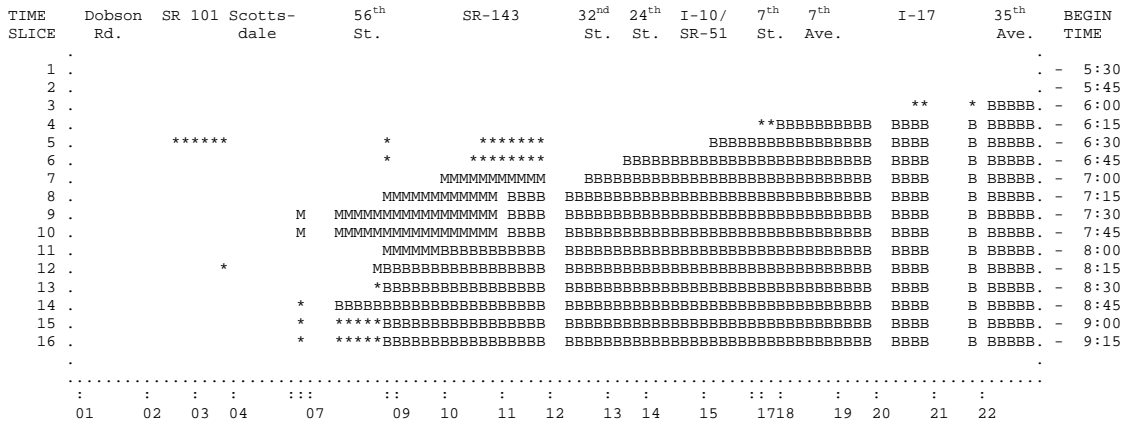
Queue Diagram of Alternative 7 for Segment G:



Alternative 10: Add a third general purpose lane through the Loop101 interchange, eliminating the existing lane drop. Add an auxiliary lane from the Loop 101 on-ramp to the Scottsdale Road off-ramp

Result: Similarly to Alternative 10, overall travel time will increase slightly due to the added demand downstream from the Loop 101 interchange. The addition of an auxiliary lane does not provide any significant benefit.

Queue Diagram of Alternative 11 for Segment G:



ANALYSIS SUMMARY – SEGMENT G

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	16110	15561	31670	29.1
Alternative 1	15872	16893	32764	30.2
Alternative 2	24724	5806	30530	17.5
Alternative 3	16072	15628	31700	29.1
Alternative 4	16028	15564	31592	30.3
Alternative 5	22298	10998	33295	20.3
Alternative 5A	20724	11062	31786	22.3
Alternative 6	19175	11447	30622	24.3
Alternative 7	19235	11152	30387	26.1
Alternative 8	16105	15561	31665	29.1
Alternative 9	17953	14593	32546	27.8
Alternative 10	17809	14593	32402	28.1

Conclusions/Recommendations:

1. On this freeway section, the do nothing alternative may be the most appropriate. Improvements that will increase the capacity of either the Loop 101/Loop 202 interchange or the Loop 202/SR-51/I-10 interchange will increase demand and congestion on the downtown section of I-10. The current bottlenecks meter the demand entering this downtown section.
2. Several improvements that can be considered include adding a general purpose lane to westbound I-10 in the tunnel area (7th Street to 7th Avenue) and allowing all traffic to exit I-10 using the left-side 3rd Street off-ramp. Opening up the 3rd Street off-ramp should be carefully evaluated to determine the operational and safety impacts on I-10.
3. Although it was not quantitatively evaluated, reconstruction of the westbound 7th Street off-ramp to increase the capacity at the ramp/7th Street intersection should be considered. Currently, the ramp approach includes dual left-turn and dual right-turn lanes. Even with this approach capacity and the storage provided on the 2-lane ramp, ramp queues still back up onto I-10 during peak periods. Lengthening the dual left and right-turn lanes would add capacity to the ramp approach, allowing a higher number of vehicles to get through the signalized intersection.
4. Adding an auxiliary lane from the Loop101 on-ramp to the Scottsdale Road off-ramp will reduce some of the problems associated with merging.